

4/1/93-01457

**SECOND ADDENDUM**  
**FINAL PROJECT PLANS**  
**INSTALLATION RESTORATION PROGRAM**  
**CAMP ALLEN LANDFILL - AREA B**  
**NAVAL BASE, NORFOLK, VIRGINIA**  
**CONTRACT TASK ORDER 0176**

*Prepared For:*

**DEPARTMENT OF THE NAVY**  
**ATLANTIC DIVISION**  
**NAVAL FACILITIES**  
**ENGINEERING COMMAND**  
*Norfolk, Virginia*

*Under the:*

**LANTDIV CLEAN Program**  
**Contract N62470-89-D-4814**

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## 1.0 INTRODUCTION

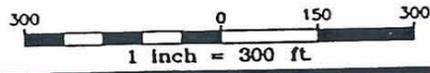
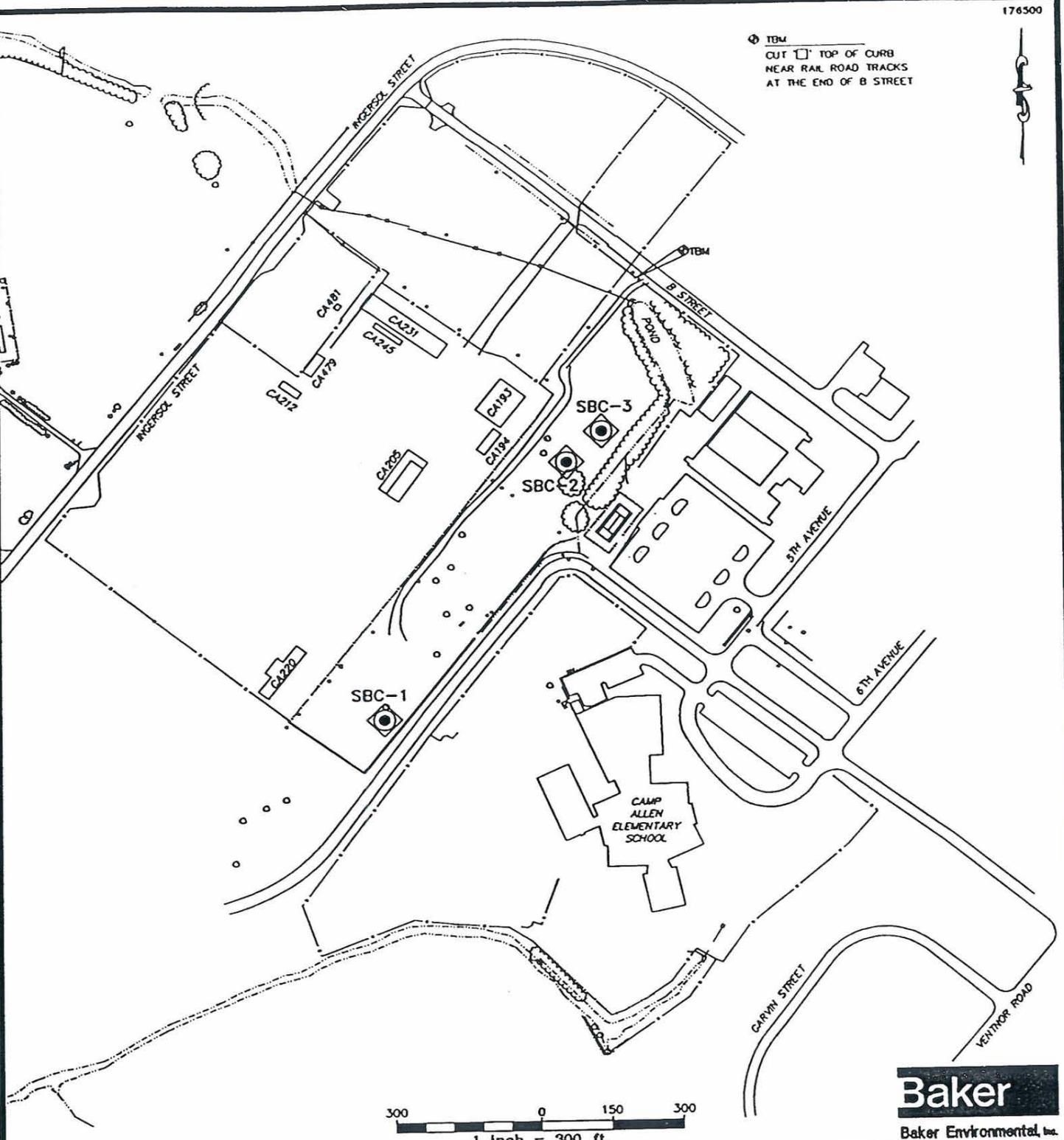
This document presents the Second Addendum to the Final Project Plans, submitted on 23 April 1992, for Contract Task Order (CTO) 0084, Remedial Investigation/Feasibility Study (RI/FS) for the Camp Allen Landfill Site - Areas A and B, Naval Base, Norfolk, Virginia; the First Addendum had been submitted on 7 December 1992. This Second Addendum appears under CTO-0176, having the Scope of Work (SoW) for Appendix A dated 17 March 1993. Baker Environmental, Inc., (Baker) is the prime contractor for the Comprehensive Long Term Environmental Action Navy Program (Navy CLEAN) under which this CTO is being performed.

This Second Addendum to the Final Project Plans has been prepared to present the revised objective and performance requirements of Section V of the 17 March 1993 SoW. LANTDIV is planning a removal action at Area B of the Camp Allen Landfill. To that end, a preliminary characterization of material for disposal has been specified. The expectation of this characterization is to provide excavation/disposal/treatment contractors with an accurate description of the effective nature of site materials for operational purposes. Following this characterization, an Engineering Evaluation/Cost Analysis (EE/CA) and Removal Action Requirements Package, also specified by CTO-0176, will be prepared.

As indicated, the objective of this part of the 17 March 1993 SoW (Section V, Paragraphs A through E) is to contribute to the technical support by field evidence of the EE/CA. This will be limited to the characterization of the disposal material for handling and compatibility; the other information to be relied upon by the EE/CA appears in other sources, including the RI/FS of CTO-0084.

The 17 March 1993 SoW provides that the objective will be obtained by limited physical and chemical analyses of individual samples from three stations (stations SBC-1, SBC-2 and SBC-3) within the most likely area of disposal at Area B (Figure 1-1). The limited analyses appear as the RCRA characteristics and the TCLP-characterization tests (Table 1-1).

⊕ TBM  
CUT □ TOP OF CURB  
NEAR RAIL ROAD TRACKS  
AT THE END OF B STREET



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**LEGEND**

SBC-1  
 PROPOSED CHARACTERIZATION BORING STATION

**FIGURE 1-1**  
**BASE MAP**  
**AREA B**  
**CAMP ALLEN LANDFILL**

NORFOLK NAVAL BASE  
NORFOLK, VIRGINIA

SOURCE: MILLER-STEPHENSON & ASSOC. JUNE 1992

TABLE 1-1

## RCRA CHARACTERISTICS AND TCLP CHARACTERIZATION TESTS

## I - RCRA - CHARACTERIZATION (SW-846)(1)

<u>Parameter</u>	<u>Method</u>
Ignitability	1010
Corrosivity (pH)	9045
Reactivity	7.3.3.2 (CN) 7.3.4.2 (S)

II - TCLP - ANALYTES (SW-846)(2)  
[Extraction Method 1311]

	<u>Parameter</u>	<u>Method</u>
Volatile Organic Compounds (VOC)	Benzene	8240
	Carbon tetrachloride	
	Chlorobenzene	
	Chloroform	
	1,2-Dichloroethane	
	1,1-Dichloroethylene	
	Methyl ethyl ketone	
	Tetrachloroethylene	
	Trichloroethylene	
Vinyl chloride		
Semivolatile Organic Compounds (SVOC)	Pyridine	8270
	2,4-Dinitrotoluene	
	Hexachlorobenzene	
	Hexachloro-1,3-butadiene	
	Hexachloroethane	
	Nitrobenzene	
	1,4-Dichlorobenzene	
	Methylphenols (total)	
	Pentachlorophenol	
	2,4,5-Trichlorophenol	
	2,4,6-Trichlorophenol	
Pesticides	gamma-BHC (Lindane)	8080
	Heptachlor	
	Heptachlor epoxide	
	Endrin	
	Methoxychlor	
	alpha-Chlordane	
	gamma-Chlordane	
Toxaphene		
Herbicides	2,4-D	8150
	2,4,5-TP (Silvex)	

TABLE 1-1 (Continued)

RCRA CHARACTERISTICS AND TCLP CHARACTERIZATION TESTS

II - TCLP - ANALYTES (SW-846)<sup>(2)</sup> - Continued  
 [Extraction Method 1311]

	<u>Parameter</u>	<u>Method</u>
Metals	Arsenic	6010
	Barium	6010
	Cadmium	6010
	Chromium	6010
	Lead	6010
	Selenium	6010
	Silver	6010
	Mercury	7470

(1) Sample container: 1 x 8 oz. glass or plastic  
 Preservation: Cool to 4°C  
 Holding time: Not defined

(2) Sample containers: 2 x 8 oz. glass  
 Preservation: Cool to 4°C  
 Holding time:

<u>Sequence</u>	<u>From: Collection</u> <u>To: TCLP Extraction</u>	<u>TCLP Extraction</u> <u>Organic Extraction</u>	<u>Organic Extraction</u> <u>Analysis</u>
VOC	14 days	--	14
SVOC	14 days	7	40
Mercury	28 days	--	28
Metals (except mercury)	180 days	--	180

## **2.0 CTO TASKS**

The investigation for this addendum comprises:

- **Task 1 - Soil Sampling:** Sampling of soil at three stations within the disposal features of Area B;
- **Task 2 - Characterization Analyses:** Analyzing these three samples for RCRA-characteristics and TCLP-characterization;
- **Task 3 - Quality Assurance (QA) Provisions:** Conducting a Quality Assurance (QA) program at the level appropriate to the objective;
- **Task 4 - Project Control Documents:** Providing this set of Project Plans appearing as addenda to the individual RI/FS plans and concerning these Tasks 1 through 5; and,
- **Task 5 - Surveying and Mapping:** Providing data and representations from a licensed land surveyor to establish the horizontal and vertical control of the operations area for the engineering plan of the EE/CA.

These Tasks 1 through 5 correspond, respectively, to Paragraphs A through E of Section V of the 17 March 1993 SoW and are discussed below in the addenda to the project plans (Sections 3, 4 and 5):

- **Section 3: Second Addendum - Work Plan (WP-2A)**
- **Section 4: Second Addendum - Sampling and Analysis Plan (SAP2A)**
  - ▶ **Section 4.1: Second Addendum - Field Sampling Plan (FSP-2A)**
  - ▶ **Section 4.2: Second Addendum - Quality Assurance Plan (QAP-2A)**
- **Section 5: Second Addendum - Health and Safety Plan (HASP-2A)**

Prior to initiating field activities, procurement of support services such as land surveying, drilling and laboratory analysis will be performed in accordance with the Navy CLEAN Contract Procurement Manual.

### 3.0 SECOND ADDENDUM - WORK PLAN

#### 3.1 Task List and Schedule - Field Program

The Second Addendum to the Work Plan (WP-2A) for the field investigation of CTO-0176 includes:

- Task 1 - Soil Sampling
- Task 2 - Characterization Analyses
- Task 3 - Quality Assurance (QA) Provisions
- Task 4 - Project Control Documents
- Task 5 - Surveying and Mapping

The calendar schedule for CTO-0176 appears in Appendix A, Section 7, dated 17 March 1993.

The items relevant to the field program are:

<u>REQUIREMENT</u>	<u>SUBMITTAL DATE</u>
Draft Project Plans	29 March 1993
Comments to A/E	31 March 1993
Final Project Plans	02 April 1993
Begin Test Borings	12 April 1993*

\* LANTDIV-EIC has agreed that drilling on 14 April 1993 will satisfy this performance date.

The remaining items of the schedule refer to the EE/CA and related Removal Action documents.

#### 3.2 Task 1 - Soil Sampling

Three stations within the disposal features of Area B have been identified for soil sampling; Figure 1-1 indicates the approximate locations. These stations have been sited on the basis of physical, chemical and geophysical information developed during the RI/FS. Specifically, the geophysical interpretation indicates the presence of a trench in the vicinity of Soil Boring SBB-8; chemical analyses indicate the presence of contaminants in high concentration in the soil at SBB-6 and 7, and in lesser concentrations at SBB-4, 5 and 8; and the description of disposal activities indicates that several trenches of 150 feet length were distributed within Area B. The siting of data stations for this investigation reflects these observations, which are summarized on Figure 3-1.

TBM  
CUT 1' TOP OF CURB  
NEAR RAIL ROAD TRACKS  
AT THE END OF B STREET



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**LEGEND**

- SBB-01 ● SOURCE CHARACTERIZATION BORING LOCATION
- GW-5 ◻ MONITOR WELL LOCATION
- GEOPHYSICAL INDICATION OF METALLIC DEBRIS
- . - . - . GEOPHYSICAL INDICATION OF DISPOSAL TRENCH

**FIGURE 3-1**  
**SOURCE CHARACTERIZATION**  
**BASE MAP**  
**AREA B**  
**CAMP ALLEN LANDFILL**  
**NORFOLK NAVAL BASE**  
**NORFOLK, VIRGINIA**

SOURCE: MILLER-STEPHENSON & ASSOC. JUNE 1992

The stations selected for this study (SBC-1, SBC-2 and SBC-3) are distributed to reflect known or suspected areas of the greatest concentration of contaminants. Since this is not a site investigation, the stations are not distributed uniformly or according to transport paths. Station SBC-1 is located in an area of metallic debris indicated by geophysical investigation. Station SBC-2 lies near a disposal trench indicated by geophysical investigation and near station SBB-7, where high concentrations of contaminants had previously been found. Station SBC-3 lies in the trench indicated by geophysical investigation and near station SBB-8, where high concentrations of contaminants had previously also been found.

At each data station, a soil boring will be advanced to 10 feet of depth or to the water table, whichever is greater. Samples from Standard Penetration Tests (SPT - ASTM Method 1586-D) will be visually described. Part of each SPT sample will be reserved for compositing into a single sample for chemical analysis covering the interval of 0.5 feet of depth to the final depth; however, should a particular layer indicate a high release of volatile organic compounds detected by PID, the sample will be taken from that layer and from an equivalent layer in a second boring at that station (Section 4.1.1.2). The samples will be analyzed according the provisions of Task 2.

The information developed from these three data stations, although of a different sort from that of the RI/FS, will contribute to the preparation of the Removal Action documents. The distribution and number of data stations are sufficient to this purpose.

### **3.3 Task 2 - Characterization Analyses**

The purpose of this study is to support an engineering design following the detailed characterization by the site investigation of the RI/FS. This study requires analyses suited only to the requirements of that design, which, in this case, provides off-site disposal. The types of analyses most appropriately addressing off-site disposal are the RCRA-characteristics tests and the TCLP-characterization analyses (Table 1-1); these analyses apply directly to the processes of mixing, transporting and disposing of materials. On the other hand, the more extensive and better documented analyses of the RI/FS (for example, the Target Compound List with Contract Laboratory Program procedures - TCL/CLP) does not provide information directly relevant to the operational processes of mixing, transporting and disposing of materials; TCL/CLP is not, therefore, suitable to this present study.

### **3.4 Task 3 - Quality Assurance (QA) Provisions**

The laboratory selected for this CTO has been approved by NEESA and follows NEESA procedures, including administrative and technical reporting. The laboratory approval form will be submitted within 10 days of receipt of notice to proceed with the field program.

Level B will be used for QA of CTO-0176. Considering the limited purpose of the present study, the level of Quality Assurance (QA) need not be as strict as that used in the RI/FS for CTO-0084:

- Level D is suitable to the TCL/CLP of the RI/FS, and contributes to the development of the Risk Assessment and to the defensibility of the data and analyses; this limited study does not require a continuation of the QA Level D enforced during the RI/FS for CTO-0084.
- Level C applies mainly to the detailed laboratory analyses of SW-846, and not to the RCRA-characteristics and the TCLP-characterization tests planned for this study; it is, therefore, not appropriate.
- Level B provides QA for tests conducted at the field level, which include the RCRA-characteristics and the TCLP-characterization tests planned for this study; it is, therefore, the highest level directly appropriate to CTO-0176.
- Level A provides QA for transient measurements taken in the field; this level is not appropriate to the purpose of this study.

By agreement with LANTDIV-EIC on 22 March 1993, Baker proposed to LANTDIV-PM and LANTDIV-CS that the CLP analyses appearing on Attachment A.3 (Ref #3) of the Fee Proposal dated 11 March 1993 be deleted for the reasons supporting the selection of QA Level B.

### **3.5 Task 4 - Project Control Documents**

Following the provisions of Section V, Paragraph D of the 17 March 93 Scope of Work, and following the agreement of the Fee Proposal dated 11 March 1993, the project plans comprise only addenda to the existing and approved plans, and address only the tasks listed in Section 2.

Baker will provide two bound copies of the Draft Project Plans and two bound copies of the Final Project Plans to LANTDIV. The Activity will receive one bound copy of each edition. One unbound copy of each edition will also be sent to LANTDIV.

### **3.6 Task 5 - Surveying and Mapping**

A surveyor licensed in the Commonwealth of Virginia will be contracted to provide, according to best professional practice and regulated standards, a detailed site map with horizontal and vertical control suitable to the purposes of the EE/CA. This site map will include the perimeter of Area B not previously surveyed during the RI/FS of CTO-0084, focusing on construction staging locations.

Additionally, the representations of the site map will be augmented with information from the RI/FS of CTO-0084 and LANTDIV comments on wetlands designations, as appropriate.

#### **4.0 SECOND ADDENDUM - SAMPLING AND ANALYSIS PLAN**

The Second Addendum to the Sampling and Analysis Plan (SAP-2A) provides details of implementation and quality control for the activities of WP-2A described above. SAP-2A has two main divisions: FSP-2A and QAP-2A. FSP-2A is concerned with the implementation of activities, while QAP-2A considers the reliability and control of quality of the data associated with those activities. For the purposes of the Second Addendum, FSP-2A is most involved with Tasks 1 and 5, the soil sampling and the surveying/mapping; QAP-2A is most concerned with Task 2 (Characterization Analyses) through the implementation of Task 3 (Quality Assurance (QA) Provisions), although it has some interest in Tasks 1 and 5 also.

#### **4.1 Second Addendum - Field Sampling Plan**

The Second Addendum to the Field Sampling Plan (FSP-2A) principally reflects the field activities of the Task 1 soil sampling and the Task 5 surveying/mapping.

##### **4.1.1 Task 1 - Soil Sampling**

###### **4.1.1.1 Station Siting and Utility Clearance**

The soil sampling at the three stations designated on Figure 1-1 have been approximately located according to the available information cited in Section 3.2; these locations will be finalized by inspection of field conditions prior to start of drilling. As the locations are finalized, Activity personnel will be requested, in the field, to clear the locations of utilities; following this clearance, drilling will commence.

###### **4.1.1.2 Drilling Procedures and Sample Collection**

Drilling will proceed through an appropriately qualified contractor licensed by the Commonwealth; Commonwealth regulations will be followed with required documentation provided. The borings are expected to extend 10 feet below ground surface or to the water table, whichever is greater. [Prior to drilling, the water levels in nearby wells, GW-4 and GW-5, will be measured to indicate the expectable final depths; present indications are that groundwater will be intercepted about three feet below ground surface, providing about seven feet of saturated soil for the composite sample.] Drilling will be by hollow-stem auger (HSA) and Standard Penetration Testing (SPT). The SPT sampler will be advanced ahead of the

auger bit, with 24-inch samples taken on 2-foot centers beginning at the surface and ending at the final depth. The HSA will have an inner diameter of about 4 inches; the SPT will have a split-spoon sampler with an inner diameter of about 1.4 inches. The SPT will follow the guidelines of ASTM Method 1586-D according to field conditions, with the blow-counts recorded for each 6-inch interval.

The site geologist will observe the drilling activities, visually describe each SPT sample and collect the composite sample at each station for analysis at the selected laboratory. Part of each recovered soil core will be visually described; the remainder of the core will be reserved for compositing into the sample for the particular station. Visual description will proceed following the guidelines of the Uniform Soil Classification System (USCS), indicating soil type, color, moisture content, relative density and other relevant information.

The SPT sampler can be expected to provide a maximum volume of about 575 ml (milliliters); usually, however, the sampling conditions reduce this recovered volume significantly. There are two options for collection of the chemical sample:

- 1 - Compositing over the length of the bore; or,
- 2 - Discrete sampling from a particular layer demonstrating a high release of volatile organic compounds detected by PID.

Under the first option, at each station, the composite sample will be mixed from the reserved part of each core between 0.5 feet below ground and the final depth. With an expected final depth of 10 feet, this will allow a maximum of five SPT cores, with the first core effectively being a maximum of 18 instead of 24 inches in length. This allows a probable maximum volume of about 2500 ml, with approximately 25 percent (about 625 ml) used for visual classification and approximately 75 percent (about 1875 ml) reserved for chemical analysis. The RCRA-characteristics tests and the TCLP-characterization analyses require about 710 ml (respectively, one 8-ounce jar and two 8-ounce jars). There should be sufficient volume of sample reserved (710 ml required against 1875 ml available) for the analyses; however, considering the usual exigencies of field testing, only about half of the probable maximum volume may be available (about 950 ml). Should the initial boring at a single station fail to produce sufficient volume for chemical analysis, a second boring at that station will be made; the sample will be composited from both borings over the equivalent lengths of bore to the final depth, but visual descriptions will be provided only for the initial boring.

Experience in drilling of the SBB-series in Area B indicates that the recovery ratio of samples is about 67 percent, ranging in particular borings between 43 and 76 percent. This gives an expectable volume for each SPT averaging about 385 ml and ranging between about 245 and 435 ml.

Under the second option, at appropriate stations, the sample will be taken from the layer showing a release of volatile organic vapor. However, since the maximum volume of recovered sample would be about 575 ml, with about 145 ml used for visual classification and about 430 ml available for chemical analysis, insufficient volume will be recovered from a given layer in a single bore for use. Multiple borings at that particular station will be advanced to the indicated layer for recovery of the balance of the sample for chemical analysis, with the visual description made only on the sample for that layer from the initial boring.

The reserved part of each SPT will be placed in sample jars marked for each station (SBC-1, SBC-2 or SBC-3) and for the relevant sampling level (probably 0-2, 2-4, 4-6, 6-8 and 8-10 feet). Under the first option at a particular station, all of the reserved material from each level will be sent to the laboratory for compositing and analysis. Under the second option, the reserved material from the target level (for example, 4-6 feet from the first and second borings at station SBC-2) will be sent to the laboratory for compositing and analysis; the remaining material reserved at that particular station will be returned to the borehole as backfill, with the sample jars placed in the decontamination drums for disposition.

#### 4.1.1.3 Station Abandonment

Following recent guidelines from the Environmental Protection Agency (EPA), spoils not sent to the laboratory from a boring will be returned to that boring following screening by Photo-Ionization Detector (PID). The remainder of the boring will be sealed with a bentonite/cement grout poured from the surface.

#### 4.1.1.4 Decontamination Requirements

The purposes of decontamination are only to reduce the potential cross-contamination between data stations, and to clean the equipment on arrival on site and departure off site. Decontamination of drilling tools and sampling equipment, before and after contact with site soils, will follow the standard practice of steam-cleaning, washing with a non-phosphate

detergent solution, rinsing with distilled water and final-rinsing with isopropanol, followed by air-drying. Decontamination fluids and materials, to include expended protective gear, will be contained at the temporary decontamination pad on site; the containment drums will be properly labeled and taken to the general drum-storage area for disposition.

#### 4.1.1.5 Personnel Protection

Field activities are expected to take place in the most contaminated part of Area B. Considering the results of the RI/FS and the descriptions of disposal material, Level B is the most appropriate for protection of field personnel (Section 5.7.2).

Under Level B, a practical expectation is that an individual can perform about 75 percent of the normally useful work under Level D, while still requiring the original length of time. This indicates that, under Level D, 10 hours of useful work can be performed in 10 hours, but only 7.5 hours of useful work can be expected for 10 hours of labor under Level B. The differential time under Level B is spent on the protective equipment and personnel maintenance, and not strictly on field activities.

#### 4.1.2 **Task 5 - Surveying and Mapping**

The three boring stations will be flagged following abandonment. A surveyor licensed in the Commonwealth will be shown these stations and other control points around Area B for mapping (Section 3.6). The surveyor will then calculate and represent on a suitable drawing (D-size) horizontal and vertical control for these indicated stations along with any others necessary for the provision of a representative map. All surveying and mapping will conform to Commonwealth requirements, but shall not exceed 0.1-foot of vertical or horizontal tolerance. The contour interval will be 1-foot.

Baker's field representative need not be present during the surveying. The surveyor will be required to provide the completed and sealed report for Area B within 30 days of having been shown the data stations.

#### 4.2 Second Addendum - Quality Assurance Project Plan

The Second Addendum to the Quality Assurance Plan (QAP-2A) provides quality control equivalent to EPA Level II (Section 3.4), herein called Level B. The provisions of Level B

apply primarily to the chemical analyses of the soil samples. Other provisions of best professional practice apply to the drilling and sampling procedures and will be followed by the field team; these are reflected in the Standard Operating Procedures (SOP) cited below.

#### **4.2.1 Quality Control Procedures - Laboratory**

The analyses for RCRA-characteristics (Table 1-1) will require a sample volume of eight ounces (about 235 ml) in a single jar; the analyses for TCLP-characterization will require two such jars (about 475 ml). The analyses for RCRA-characteristics are: Ignitability - D001; Corrosivity - D002; and Reactivity - D003. TCLP-characterization follows EPA Designations D004 through D043, for the parameters listed on Table 1-1.

Quality control procedures for the laboratory are described in 'Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA,' Interim Final, EPA 540 G-89 004, OSWER Directive 9355 3-01, October 1988. The laboratory will comply with the relevant provisions of this guideline, along with NEESA requirements at a level of quality assurance equivalent to EPA Level II. The NEESA requirements will take precedence. The qualifications summary for the contracted laboratory appears in Attachment 4-A/1.

#### **4.2.2 Quality Control Procedures - Field**

The general provisions of best professional practice include observance of the standard health and safety procedures, following the relevant ASTM guidelines, conforming to usual measurement tolerances, and so forth. The exercise of judgment by the Site Geologist will reflect his interpretation of best professional practice according to conditions encountered at the site. The relevant SOP for this study are included in Attachment 4-A/2:

F101: Borehole and Sample Logging

F102: Soil and Rock Sample Acquisition

F202: Water Level, Water-Product Level, and Well Depth Measurements

F203: Photoionization Detector (PID)

F301: Sample Preservation and Handling

F302: Chain-of-Custody

F303: Field Logbook

F501: Decontamination of Drilling Rigs and Monitoring Well Materials

F502: Decontamination of Chemical Sampling and Field Analytical Equipment

### **4.2.3 Quality Control Procedures - Surveying**

The requirements for land surveying are presented in Sections 3.6 and 4.1.2. All surveying and mapping will conform to Commonwealth requirements, but shall not exceed 0.1-foot of vertical or horizontal tolerance. The contour interval will be 1-foot. The datum will be the State Plane Coordinate System, or some other general system as otherwise specified by contract. The report from the surveyor will bear the surveyor's seal and a statement of certification.

**5.0 SECOND ADDENDUM - HEALTH AND SAFETY PLAN (REVISION 1.0)**

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### ATTACHMENTS

5-A	Baker Environmental, Inc. (Baker) Safety Standard Operating Procedures
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PROJECT HEALTH AND SAFETY OFFICER (PHSO): Barbara Cummings

The Project Health and Safety Officer is responsible for general development and monitoring of compliance with the HASP. The PHSO will be the primary contact for inquiries as to the contents of the HASP. The PHSO will be consulted before changes to the HASP can be approved or implemented. The PHSO will also:

- Develop new protocols or modify the HASP as appropriate and issue amendments to the HASP.
- Resolve issues that arise in the field with respect to interpretation or implementation of the HASP.
- Monitor the field program through a regular review of field health and safety records, on-site activity audits, or a combination of both.
- Determine that all on-site personnel have received the required training and medical surveillance prior to entry onto the site.
- Coordinate the review, evaluation, and approval of the HASP.
- Approve changes to assigned PPE.

SITE MANAGER: John Barone

The Site Manager is responsible for assuring that all day-to-day activities are conducted in accordance with the HASP. The Site Manager has the immediate authority to suspend field activities if employees are subjected to a situation that can be immediately dangerous to life or health. The Site Manager's responsibilities include:

- Assuring that the appropriate Baker health and safety equipment and PPE has arrived on site and that it is properly maintained.
- Coordinating overall site access and security.
- Controlling visitor access to hazardous areas.

- Approving all on site activities.
- Coordinating site safety and health issues with the SHSO.
- Assisting the SHSO in coordinating emergency procedures with the Naval Activity, emergency medical responders, etc., during site mobilization activities.
- Assuring compliance with site sanitation procedures and site precautions.
- Coordinating activities with Baker and subcontractor personnel.

**SITE HEALTH AND SAFETY OFFICER (SHSO):** Barbara Cummings

The SHSO is responsible for the implementation of the HASP Addendum. The SHSO will also:

- Coordinate the pre-entry briefing and periodic (weekly) briefings.
- Assure that Baker monitoring equipment is properly calibrated and properly used.
- Assure compliance with site sanitation procedures and site precautions.
- Manage health and safety equipment, including instruments, respirators, PPE, etc., that is used in field activities.
- Arrange emergency response provisions in cooperation with Naval Activity Requirements, emergency medical care, etc., during site mobilization activities.
- Monitor conditions during field activities to assure compliance with the HASP and evaluate if more stringent procedures or a higher level of PPE should be implemented, and informing the PHSO and Project Manager.
- Prepare a daily/weekly report (in the field log book) as necessary, which may include all relevant health and safety events; recordkeeping of all personnel and site monitoring information; accident investigation and reporting; safety inspections;

maintain a record of site conditions, personnel involved in field activities, and any other relevant health and safety issues.

- **Oversee the decontamination of personnel and equipment.**
- **Determine safe boundary procedures for activities requiring Level C or higher protection levels.**
- **Suspend field activities if the health and safety of personnel are endangered.**
- **Audit the subcontractor training and medical surveillance records to verify compliance.**
- **Act as the Emergency Coordinator.**

**FIELD TEAM LEADER:** \_\_\_\_\_ **Tom Trebilcock** \_\_\_\_\_

**The Field Team Leader is responsible for:**

- **Safety issues relevant to the tasks under his/her direction.**
- **Determining safe boundary procedures for activities requiring Level D or D+ protection levels.**
- **Assuring that PPE is properly maintained.**
- **Following the responsibilities as outlined under Field Team Members, below.**

**FIELD TEAM MEMBERS: (Not Applicable)**

**The Field Team Members are responsible for:**

- **Familiarity with the HASP and HASP Addendum.**
- **Attending training sessions to review the HASP Addendum, and staying informed of additional safety and health information.**

- Being alert to identified and unidentified hazards.
- Reporting unidentified hazards to the SHSO and Site Manager.
- Offering suggestions, ideas, or recommendations that may improve or enhance site safety.
- Complying with the contents of the HASP and HASP Addendum.
- Conducting site activities in an orderly and appropriate manner.

Subcontractor personnel are responsible for:

- Complying with the conditions as outlined under Field Team Members.
- Obtaining the appropriate training, fit testing, and medical requirements under 29 CFR 1910.120 and 1910.134, and providing this documentation to the Site Manager.
- Complying with the training and medical surveillance requirements as outlined in HASP and providing his/her own PPE that meets or exceeds the level of protection as outlined in this Addendum.

**SUBCONTRACTOR COMPANIES:**

Drilling Operations:	<u>Industrial Marine Services, Inc.</u>
Survey Operations:	<u>ENISCO-Wadsworth/Alert Laboratories, Inc.</u>

**NAVFACENGCOM REPRESENTATIVES:**

Ms. Susan Hauser, P.E., EIC	(804) 445-8856
-----------------------------	----------------

**ACTIVITY/BASE REPRESENTATIVES:**

*Mr. Dave Forsythe*

(804) 444-3009

**FEDERAL/STATE/LOCAL REPRESENTATIVES:**

Mr. Robert Thompson (EPA)

Ms. Lisa Ellis (Dept. of Waste Management, Commonwealth of Virginia)

**5.3 Site Work Plans**

WP-2A, FSP-2A, and QAP-2A are discussed in previous sections of this document.

**5.4 Site Concerns**

There are several potential chemical, physical, and environmental hazards associated with the tasks of these activities, therefore, these hazards are discussed below.

**5.4.1 Chemical Hazards**

The chemical hazards are associated with those chemicals identified in the previous study related to Soil Boring Numbers SBB-06, SBB-07, and SBB-08. The contamination consists of various volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs), some pesticides/PCBs, and various metals. Each of the VOCs is included along with the SVOCs (grouped as polynuclear aromatic hydrocarbons) in Tables 5-1 and 5-2, respectively. Material Safety Data Sheets (MSDSs) for these chemicals are included in Attachment 5-B. Procedures to follow in the event of a chemical exposure, are included as Attachment 5-C.

TABLE 5-1

**CHEMICAL/PHYSICAL PROPERTIES OF CHEMICALS DETECTED DURING SOIL BORING/SAMPLING  
AT AREA B**

Chemical	Subsurface Soil Boring	Highest Concentration Detected (ppb)	Exposure Limit (EL) <sup>(a)</sup> (ppm)	IDLH <sup>(b)</sup> (ppm)	Vapor Pressure <sup>(c)</sup>	Specific Gravity <sup>(d)</sup>	Ionization Potential
Methylene Chloride	SBB-08	200	25	5,000 (CA)	350 mm	1.33	11.32 eV
Acetone	SBB-06 SBB-07	6000 J <sup>(e)</sup>	750	20,000	180 mm	0.79	9.69 eV
1,2-dichloroethene	SBB-07 SBB-08	4,300	200	4,000	180 - 264 mm	1.27 (at 77°F)	9.65 eV
Ethylbenzene	SBB-06	30,000	100	2,000	10 mm (at 79°F)	0.87	8.76 eV
Hexone (4 methyl-2 pentanone)	SBB-07 SBB-08	2,200	50	3,000	16 mm	0.80	9.30 eV
Toluene	SBB-06 SBB-08	16,000	100	2,000	20 mm (at 65°F)	0.87	8.82 eV
1,1,1-Trichloroethane (Methyl Chloroform)	SBB-07	3,100	10 (skin)	500 (CA)	19 mm	1.44	11.00 eV
Xylenes	SBB-06 SBB-08	200,000	100	1,000	7-9 mm	0.86 to 0.88	8.44 - 8.56 eV
2-Butanone (MEK)	SBB-06	10,000 J	200	3,000	71 mm	0.81	9.54 eV
Polynuclear Aromatic Hydrocarbons (as Coal Tar Pitch Volatiles)	SBB-06 SBB-07 SBB-08	23 J to 14,000	0.2 mg/m <sup>3</sup>	700 mg/m <sup>3</sup> (CA)	NA	NA	NA

(a) EL - Exposure Limit = A time-weighted average concentration for a normal eight-hour work day and 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without expected adverse effect. The EL represents published Exposure Levels according to the following hierarchical order: (1) OSHA PELs; (2) NIOSH RELs; (3) ACGIH TLVs; and, (4) other recognized sources.

(b) IDLH - Immediately Dangerous to Life or Health.

(c) Vapor Pressure = Expressed as mm/Hg at 68°F (unless otherwise mentioned).

(d) Specific Gravity = At 68°F (unless otherwise mentioned).

(e) J = Estimated

CA - Suspected or Proven Carcinogen

ppm - parts per million (in air)

Skin - Potential for dermal absorption

NA - Not Available

mg/m<sup>3</sup> - milligrams per cubic meter (in air)

ppb - parts per billion (in water)

TABLE 5-2

## CHEMICAL EXPOSURE INFORMATION

A summary of exposure symptoms/routes of entry for chemicals detected during soil boring/sampling at Area B.

Substance	Routes of Entry	Exposure Symptoms
Methylene Chloride	Inhalation, Ingestion, Skin/Eye Contact	Fatigue, weakness, sleepiness, light-headedness, numbness, and tingling in limbs; nausea; eye/skin irritant; carcinogen
Acetone	Inhalation, Ingestion, Skin/Eye Contact	Eye, nose, and throat irritant; headache, dizziness, dermatitis
1,2-dichloroethene	Inhalation, Ingestion, Skin/Eye Contact	Eye and respiratory irritant, CNS depression
Ethylbenzene	Inhalation, Ingestion, Skin/Eye Contact	Eye and mucus membrane irritant; dermatitis, narcosis, coma
Hexone (4-methyl - 2-pentanone)	Inhalation, Ingestion, Skin/Eye Contact	Eye, mucus membrane irritant; headache; narcosis, coma, dermatitis
Toluene	Inhalation, Absorption, Ingestion, Skin/Eye Contact	Fatigue, weakness; confusion, euphoria, dizziness, headache, dilated pupils, lacrimation, nervousness, muscle fatigue, insomnia, paresthesia, dermatitis
1,1,1-Trichloroethane (Methyl Chloroform)	Inhalation, Absorption, Ingestion, Skin/Eye Contact	Headache, lassitude, CNS depression, poor equilibrium; eye irritation; dermatitis; cardiac arrhythmias
Xylenes	Inhalation, Absorption, Ingestion, Skin/Eye Contact	Dizziness, excitement, drowsiness, incoordination, staggering gait; eye, nose, and throat irritant; cornealvacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis
2-Butanone (MEK)	Inhalation, Ingestion, Skin/Eye Contact	Eye and nose irritation, headache, dizziness, vomiting
Polynuclear Aromatic Hydrocarbons (as Coal Tar Pitch Volatiles)	Inhalation, Skin/Eye Contact	Dermatitis, bronchitis, (carcinogenic)

The Pesticides/PCBs and Metals identified during the previous study, are not included in the aforementioned tables but are listed below, due to their low potential for exposure during the soil boring operations.

<u>Metal</u>	<u>Max. Conc. (mg/kg)</u>	<u>Metal</u>	<u>Max. Conc. (mg/kg)</u>
● Antimony	8L	● Beryllium	5.6
● Arsenic	60.5	● Cadmium	1.3
● Barium	1,480	● Chromium	24.9
● Iron	22,700	● Cobalt	16.2
● Lead	19.8 J	● Copper	63.6
● Manganese	63.5 J	● Mercury	0.68
● Nickel	38.7	● Thallium	2
● Zinc	47.9 J	● Vanadium	149
● Selenium	5.7 J	● Silver	0.49

J = estimated      L = biased low

#### 5.4.2 Physical Hazards

The physical hazards include working around heavy equipment; all personnel are instructed to maintain safe distances from heavy equipment operations.

#### 5.4.3 Environmental Hazards

The environmental hazards include exposure to native flora and fauna as discussed in the HASP.

#### 5.4.4 Tasks-Specific Hazards

Listed below are summaries for the hazards associated with each of the site tasks.

##### Task 1 - Soil Boring-Sampling

###### *Chemical*

- Potentially-contaminated mud, etc., in eyes or on skin.
- Skin contact with contaminated soil.
- Ingestion of contaminated soils from hand to mouth contact.
- Inhalation of volatile contaminants or volatile fraction of semivolatile contaminants.

### *Physical/Environmental*

- Elevated noise levels from heavy equipment operations.
- Lifting hazards (muscle strain).
- Skin irritation from contact with insects and vegetation.
- Contact with underground utilities.
- Interaction with native and potentially hostile animal life.
- Heavy objects landing on foot/toe or head.
- Strips/trips/falls from sloped, uneven terrain.

### Task 2 - Surveying

#### *Chemical*

- Ingestion of contaminated material from hand to mouth contact.

#### *Physical/Environmental*

- Slips/trips/falls - sloped, uneven terrain; crawling over and under obstacles.
- Skin irritation from contact with insects and vegetation.
- Interaction with native and potentially hostile animal life.

## **5.5 Site Conditions**

The prevailing winds are expected to be from the west-southwest. Anticipated weather conditions include mild to warm temperatures between 50° and 75°F. The on-site Command Post will be the Baker Site Trailer which will be located in the Support Zone. Work Zones are to be established according to the HASP. The Buddy System will be in effect at all times when there is a known or suspected hazard. Personnel will not perform site investigative activities without being accompanied by additional site personnel. Sanitation/site precautions will be followed as defined in the HASP.

## **5.6 Monitoring Requirements**

The frequency of monitoring, according to the task and instrumentation, is provided in Table 5-3. Instrumentation to be used will include a PID/FID, and an Oxygen/Combustible Gas Meter as outlined in Section 5.6.2. Monitoring will be performed as follows.

### **5.6.1 Point Source**

Point source monitoring (monitoring at the source of the sampling/investigative activity) will be performed during each sampling task, according to Table 5-3.

**TABLE 5-3**

**MONITORING EQUIPMENT AND FREQUENCY FOR EACH TASK  
CONDUCTED AT AREA B**

<b>Job Task</b>	<b>PID or FID(1)</b>	<b>Oxygen/ Combustible Gas Meter</b>
Soil Boring Sampling	C	C
Surveying	NR	NR

- I = Initially - At start of job task to confirm designated protection level.
- P = Periodically - When site condition or set-up changes, or when a new area is entered.
- C = Continuously - Monitor levels continuously.
- D = At the discretion of the SHSO.
- B = Background - To determine if background levels are less than 3 mu.
- PID = Photo Ionization Detector
- FID = Flame Ionization Detector
- NR = Not Required

Note: As air concentrations are measured, they should be documented. In the case of continuous monitoring, every 15 to 30 minutes.

(1) A flame ionization detector is mandatory during all intrusive activities where methane gas is anticipated (i.e., landfills).

## 5.6.2 Personal Monitoring

Personal monitoring will be accomplished using realtime instrumentation directed at the breathing zone of work party personnel. Breathing zone (bz) monitoring will be performed initially, and each time a level is detected at the point source. The guidelines below identify the protection levels required according to the concentrations measured in the breathing zone.

### PID<sup>(1)</sup>/FID

- Background<sup>(2)</sup> = Level D
- > 1 mu above background for up to 1 continuous minute = Level C
- > 1 mu above background up to 5 continuous minutes = Level B or Stop Work and consult SHSO
- Instantaneous peak concentrations > 10 mu = Level B or Stop Work and consult SHSO

(1) PID with 11.7 eV ultraviolet lamp.

(2) Background is typically 1 to 2 mu.

### Oxygen/Combustible Gas Meter\*

#### Combustible Gas Meter

- < 10% of the Lower Explosive Limit (LEL) = continue working
- > 10% of the LEL\* = Stop Work immediately and consult SHSO

#### Oxygen Meter

- 19.5% to 22% = continue working
- < 19.5% or > 22% = Stop Work immediately and consult SHSO

\*Used to evaluate physical safety in conjunction with PID or FID.

As work progresses, the scope of monitoring may be extended based on monitoring results, odor detection, changing work conditions, and signs or symptoms of exposure. Any or all of these conditions will be immediately investigated and acted upon by the SHSO.

### 5.6.3 Perimeter Monitoring

The frequency of perimeter monitoring (monitoring performed at borders beyond the Support Zone/"fence line") will be dependent on the concentrations found in the breathing zone of work party personnel. Therefore the following action levels are in place:

- The PID/FID will be used periodically to scan the perimeter as a means of documenting any volatile releases that may extend past the work zone, when volatile concentrations exceed 50 mu at the point source or 10 mu at the breathing zone.

## 5.7 Personal Protective Equipment

### 5.7.1 Levels of Protection

The required personal protective equipment for each level of protection is listed below. Specific information regarding respiratory protection is detailed in Section 5.6.3.

Personal Protective Equipment	Level of Protection				
	B	C	D+	D	Other
Chemical-Resistant Clothing (Polyethylene-coated Tyvek®)		X	X		
Chemical-Resistant Clothing (Saranex®)	X				
Uncoated Tyvek®/Kleenguard® Coveralls					
Normal Work Clothes or Coveralls				X	
Air-Line Respirator (ALR) with 5-minute escape pack	X				
Self-Contained Breathing Apparatus (SCBA) for rescue	X	X			
Full-face Cartridge Respirator		X			
Half-face Cartridge Respirator					
Full-face Cartridge Respirator (on standby)			X		
Chemical-Resistant Gloves (Nitrile inner)	X	X	X	X	
Chemical-Resistant Gloves (Latex inner)					
Chemical-Resistant Gloves (Rubber/Neoprene outer)	X	X	X		
Chemical-Resistant Gloves (Nitrile outer)					
Work Gloves (outer)				X	
Chemical-Resistant Overboots (with steel toe and shank)					
Chemical-Resistant Overboots (w/o steel toe)	X	X	X		
Steel Toe Boots	X	X	X	X	
Safety Glasses/Goggles			X	X	
Face Shield					
Hard Hat	X	X	X		
Hearing Protection <sup>(1)</sup>	X	X	X		

- (1) Required for activities conducted near drill rigs and at the discretion of the SHSO for other Activities.

Changes to the type of PPE required under each level of protection may be instituted by the SHSO with the approval of the PHSO.

**5.7.2 Site-Specific Levels of Protection**

Based on an evaluation of potential hazards the levels of personal protection have been designated for the following tasks. Upgrading or downgrading the level of protection will be based on real time monitoring and working conditions. Changes in level of protection will be the responsibility of the SHSO.

Note: No single combination of protective equipment and clothing is capable of protection against all hazards. PPE will be used in conjunction with safe work practices, decontamination, and good personal hygiene.

Location	Job Task	Level of Protection				
		B	C	D+	D	Other
Camp Allen Landfill, Area B	Soil Boring - Sampling	X				
Camp Allen Landfill, Area B	Surveying				X	

EXCEPT IN EMERGENCY SITUATIONS, CHANGES TO THE SPECIFIED LEVELS OF PROTECTION SHALL ONLY BE MADE WITH THE APPROVAL OF THE SITE HEALTH AND SAFETY OFFICER AND THE SITE MANAGER, IN CONSULTATION WITH THE PROJECT HEALTH AND SAFETY OFFICER AND PROJECT MANAGER.

**5.7.3 Respiratory Protection**

Site-specific respiratory protection requirements as outlined below will comply with the procedures outlined in Attachment 5-A - Baker Safety SOPs. The criteria for using these types of respiratory protection have been determined by qualified Baker personnel in compliance with OSHA Standard 29 CFR 1910.134.

### Level B

Either the “North” NIOSH-certified Air Line Respirator (ALR) system (four-person manifold) with 5-minute escape pack or “North” Self-Contained Breathing Apparatus’ (SCBAs) will be used at this level. The line-of-site worker will be equipped with an SCBA on standby for emergency rescue purposes. This individual may also be responsible for monitoring the supplied air system with the SHSO’s approval.

### Level C

The “North” or “MSA” full-face NIOSH-certified negative pressure Air-Purifying Respirator (APR) with an organic vapor/HEPA cartridge is the appropriate cartridge for use with the detected hazardous materials and the measured contaminant concentrations. Upgrades/downgrades in this level of respiratory protection will be based on measured “realtime” air contaminant concentrations and the SHSO’s observations.

Cartridge changeover will occur when one or more of the following have been observed: exposure duration greater than eight hours for vapor/gas cartridges; breathing resistance; a noticeable odor or taste; eye/throat irritation; and other indicators such as end-of-service life indicators for specialty filter cartridges.

### Level D+

A NIOSH-certified negative pressure APR, meeting all the requirements identified under Level C, will remain on standby at this level.

#### **5.7.4 Care and Cleaning of Personnel Protective Equipment**

Provisions for the care and cleaning of personal protective equipment used on site can be found in Attachment 5-A - Baker Safety SOPs. Responsibility for compliance with these provisions lies with the Site Manager and/or Field Team Leader.

## **5.8 Support Information**

Information concerning Communication, Decontamination, Emergency Procedures and other subject areas not discussed in this addendum, but can be found in the HASP prepared by Baker in April 1992.

## **5.9 OSHA Training History**

Training history for project personnel is presented in Table 5-4. Qualifications for subcontractors will be reviewed prior to site startup by the SHSO. Training certificates for all site personnel will be maintained in the Baker Site Trailer.

## **5.10 Declaration of HASP Addendum Review**

All site personnel will be required to review and become familiar with this information and applicable information provided in the HASP, and sign the declaration form provided in Attachment 5-D, prior to the start of activities.

TABLE 5-4

OSHA TRAINING HISTORY OF BAKER PROJECT PERSONNEL\*

<u>Personnel</u>	<u>Anticipated Site Activities</u>	<u>Training Status</u>
Stephen Kretschman	<ul style="list-style-type: none"> <li>● Project Manager (non-field activities)</li> </ul>	<ul style="list-style-type: none"> <li>● 40-hr. training completed: NA</li> <li>● Supervisory training: NA</li> <li>● 8-hr. refresher completed: NA</li> <li>● First Aid Training: NA</li> <li>● CPR Training: NA</li> <li>● Medical surveillance: 08/92</li> </ul>
Barbara J. Cummings	<ul style="list-style-type: none"> <li>● Project Health and Safety Officer/ Site Health and Safety Officer</li> </ul>	<ul style="list-style-type: none"> <li>● 40-hr. training completed: 10/91</li> <li>● Supervisory training: 09/91</li> <li>● 8-hr. refresher completed: 08/92</li> <li>● First Aid Training: 11/91</li> <li>● CPR Training: 02/93</li> <li>● Medical surveillance: 05/92</li> </ul>
John Barone	<ul style="list-style-type: none"> <li>● Site Manager/Project Geologist</li> </ul>	<ul style="list-style-type: none"> <li>● 40-hr. training completed: 09/87</li> <li>● Supervisory training: 05/87</li> <li>● 8-hr. refresher completed: 03/93</li> <li>● First Aid Training: 04/92</li> <li>● CPR Training: 04/92</li> <li>● Medical surveillance: 07/92</li> </ul>
Tom Trebilcock	<ul style="list-style-type: none"> <li>● Environmental Scientist/ Field Team Leader</li> </ul>	<ul style="list-style-type: none"> <li>● 40-hr. training completed: 06/92</li> <li>● Supervisory training: NA</li> <li>● 8-hr. refresher completed: NA</li> <li>● First Aid Training: 07/92</li> <li>● CPR Training: 07/92</li> <li>● Medical surveillance: 07/92</li> </ul>

\* Training history for contractor personnel will be maintained in the Baker Site Trailer.

NA - Not Applicable

**ATTACHMENT 4-A/1**  
**SUMMARY STATEMENT OF LABORATORY QUALIFICATIONS**

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**MARTIN MARIETTA****MARTIN MARIETTA ENERGY SYSTEMS, INC.**POST OFFICE BOX 2003  
OAK RIDGE, TENNESSEE 37831-7201  
January 16, 1992

Ms. Kathy Ford  
Naval Energy and Environmental Support Activity  
Code 112E  
Port Hueneme, California 93043-5014

Dear Ms. Ford:

Approval of Wadsworth/Alert Laboratory, Inc., North Canton, Ohio

This is in response to your request (Ser 112E/752, dated March 29, 1991) for the approval of Wadsworth/Alert Laboratory, Inc., in accordance with the Naval Energy and Environmental Support Activity (NEESA) document *Sampling and Chemical Analysis Requirements for the Navy Installation Restoration Program*, NEESA 20.2-047B. Our records at the Analytical Environmental Support Group (AESG), of Martin Marietta Energy Systems, Inc., indicate that:

1. The laboratory quality assurance plan (LQAP) was reviewed by AESG on July 9, 1991.
2. Performance Evaluation (PE) samples were submitted to the laboratory on July 15, 1991. Remedial PE for Pesticides/polychlorinated biphenyl (PCB) analysis was submitted on December 4, 1991.
3. An audit of the laboratory facility was conducted on November 6 and 7, 1991.
4. The laboratory completed its response to the LQAP review on August 26 and December 17, 1991.
5. The laboratory successfully completed the analysis of PE samples for volatiles, semivolatiles, and metals. The laboratory responded to the PE data package review on December 17, 1991. Remedial PE for Pesticide/PCB analysis was completed by the laboratory on December 20, 1991; and was reviewed and accepted by AESG on January 6, 1992.
6. The laboratory satisfactorily responded to audit findings on December 17, 1991.

AESG disposition regarding Wadsworth/Alert Laboratory, Inc., North Canton, Ohio, is that the laboratory has completed the review process as outlined in the NEESA requirements document, and may be utilized to provide analytical support to Navy Installation Restoration Programs. The laboratory **MUST** demonstrate adherence to Navy program requirements regarding:

1. Notification of all changes in personnel, certification and laboratory affiliation.
2. Implementation of NEESA Quality Control (QC) requirements for control charts and an in-house QC program.

Ms. Kathy Ford

2

January 16, 1992

- 3. Submission of monthly progress reports on a regular basis.
- 4. Adherence to U.S. Environmental Protection Agency guidelines for analytical methods and reporting.

The following information was listed in the approval request of Wadsworth/Alert:

Project: Naval Surface Warfare Center, White Oak, MD  
 Engineering Field Division: Chesapeake Division  
 Remedial Project Manager: David J. Carver or Frank Peters, (202) 433-3760  
 Prime Contractor: Malcolm Pirnie  
 Prime Point of Contact: Mary Mullen, (304) 873-3700  
 Contract Number: N62477-85-C-0600

Please feel free to call me at (615) 574-7251, if you have any questions in this regard.

Sincerely,



Ahmed A. Halouma  
 Laboratory Review Coordinator

AAH:mpi

- cc: A. R. Barnard-Hatmaker  
 D. J. Carver/ F. Peters, Chesapeake Division  
 J. Graham, Wadsworth/Alert  
 A. A. Halouma  
 N. A. Luedtke  
 M. Mullen, Malcolm Pirnie  
 R. D. Westmoreland  
 Laboratory File - RC  
 Letter File  
 Project File - RC

**ATTACHMENT 4-A/2**  
**STANDARD OPERATING PROCEDURES**

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## **BOREHOLE AND SAMPLE LOGGING**

### **1.0 PURPOSE**

This SOP provides general reference information and technical guidance on borehole and sample logging. Borehole logs provide information that is used in the determination of geological conditions, assessment of contaminant distribution, and the evaluation of remedial actions.

### **2.0 SCOPE**

This SOP provides descriptions of the standard techniques for borehole and sample logging. These techniques shall be used to provide consistent descriptions of subsurface lithology for each boring that is logged. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer may develop adequate classifications through careful, thorough observation and consistent application of the classification procedure.

### **3.0 DEFINITIONS**

Soil classifications and terms are given in Sections 5.2 and 5.3. Rock classification and terms are presented in Section 5.4.

### **4.0 RESPONSIBILITIES**

**Project Manager** - It is the responsibility of the Project Manager to ensure that field personnel responsible for borehole logging are familiar with these procedures. It also is the responsibility of the Project Manager to ensure that the appropriate documents (e.g., test boring logs, field logbooks, etc.) have been correctly and completely filled out by the drilling inspector.

**Field Team Leader** - The Field Team Leader is responsible for the overall supervision of the drilling and boring activities, and for ensuring that each borehole is completely logged by the responsible drilling inspector. The Field Team Leader also is responsible for ensuring that all drilling inspectors have been briefed on these procedures.

**Drilling Inspector** - The drilling inspector (site geologist) is responsible for the direct supervision of boring and sampling activities. It is the Drilling Inspector's responsibility to log each boring, document subsurface conditions, complete the appropriate forms, and direct the drilling crew (or drilling supervisor).

## **5.0 PROCEDURES**

The classification of soil and rock is one of the most important jobs of a drilling inspector or site geologist. It is imperative that the drilling inspector understand and accurately use the field classification system described in this SOP to maintain a consistent flow of information. This identification is based on both visual examination and manual tests. The results of the boring activities, including soil and rock classifications, shall be recorded on a Field Test Boring Record (see Figure 1) or the field notebook.

### **5.1 Test Boring Record**

Each boring shall be fully described in a Field Test Boring Record (Figure 1). The drilling inspector shall log the boring, as it is being drilled, by recording relevant data on the Boring Record. It may be more appropriate to record the boring information in a bound field log book in cases where the information will not easily fit on the boring record. Field Test Boring Records may then be transcribed from the field log book, but must be completed at a minimum, on a weekly basis. The Field Test Boring Records must be completely filled out and signed prior to demobilization from the field activity. Field Test Boring Records must also be legible. Completed Field Test Boring Records shall be converted to report format using a Test Boring Record. An example of a completed Test Boring Record is provided in Attachment A.

The data which is to be included on the Boring Records, when applicable is listed below.

1. Project name, location, and Contract Task Order Number.
2. Date(s).
3. Identifying number and location of each boring.
4. If required, soil classifications and associated depths in accordance with the Unified Soil Classification System (see Section 5.2 and Attachment B). These classifications will be noted in the field by the drilling inspector and revised, if necessary, based on



Figure 1

# FIELD TEST BORING RECORD

SOP F101  
 Revision No.: ( )  
 Date: 01/10/92  
 Page 3 of 15

PROJECT: Building P-64  
 S.O. NO.: 19010-57-5RN BORING NO.: B-1  
 COORDINATES: EAST: \_\_\_\_\_ NORTH: \_\_\_\_\_  
 ELEVATION: SURFACE: \_\_\_\_\_ TOP OF STEEL CASING: \_\_\_\_\_

RIG: <u>Mobile B-57</u>									
	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT)	WEATHER	WATER DEPTH (FT)	TIME
SIZE (DIAM.)	<u>1-7/8" ID</u>		<u>6-1/4" ID</u>		<u>5/31/91</u>	<u>14.0</u>	<u>Sunny, 80°-90°F</u>	-	-
LENGTH	<u>2.0'</u>		<u>5.0'</u>						
TYPE	<u>STD.</u>		<u>HSA</u>						
HAMMER WT.	<u>140 lb.</u>								
WALL THICKNESS	<u>30"</u>								
TICK UP									

REMARKS: Advanced boring to 14ft taking continuous 2-foot split-spoon samples; No Monitoring Well installed - borehole grouted to surface

DRILL RECORD							VISUAL DESCRIPTION					
DEPTH	SOIL / ROCK	Sample ID / Type No. (N = No Samp.)	Samp. Rec. (Ft. & %)	SPT Blows Per 0.5'	Lab. Class	Lab. M.C. %	Classification (Grain Size, Principal Constituents, Etc.)	Color	Consist. or Density	Moisture Content, Organic Content, Plasticity, and Other Observations	SOIL / ROCK	ELEVATION
				RQD (FL & %)	Pen. Rate	PTD (ppm)	Classification (Name, Grain Size, Principal Constituents, Etc.)	Color	Hardness	Weathering, Bedding, Fracturing, and Other Observations		
1		S-1	1.3 / 2.0	3 / 7 / 9		0	TOPSOIL, grass roots;	Tan Gray	medium dense	dry		1.0'
2	2.0		65%	5			SAND, fine-grained, trace gravel, trace silt	Tan brown	loose	moist to damp		
3		S-2	1.3 / 2.0	4 / 3 / 4		0	SAND, fine-grained, trace silt, trace grass roots	Tan brown	loose	moist to damp		
4	4.0		65%	4								4.0'
5		S-3	2.0 / 2.0	11 / 12 / 10		0	SAND, fine to medium-grained, trace silt	Tan brown orange	medium dense	moist to wet; water table noted at 6.0'		
6	6.0		100%	8								
7		S-4	1.8 / 2.0	3 / 4 / 3		0	SAND, medium to coarse-grained, trace silt	Tan gray orange	loose	wet		7.0'
8	8.0		90%	4								
9		S-5	2.0 / 2.0	1 / 0 / 1		0	SAND, medium-grained, trace silt	Gray orange	loose	wet		9.0'
10	10.0		100%	1								

DRIILLING CO.: AIEC Associates BAKER REP.: R. Bonelli  
 DRILLER: M. Miller BORING NO.: B-1 SHEET 1 OF 2



# FIELD TEST BORING RECORD

SOP F101  
 Revision No.: 1  
 Date: 01/10/92  
 Page 4 of 15

PROJECT: Building P-64

S.O. NO.: 19010-51-3RN

BORING NO.: B-1

DRILL RECORD							VISUAL DESCRIPTION				
DEPTH	SOIL	Sample ID	Samp. Rec.	SPT Blows Per 0.5'	Lab. Class	Lab. M.C. %	Classification (Grain Size, Principal Constituents, Etc.)	Color	Consist. or Density	Moisture Content, Organic Content, Plasticity, and Other Observations	SOIL
	ROCK	Type No. (N = No Samp.)	(Ft. & %)	RQD (FL & %)	Pen. Rate	PIED (ppm)	Classification (Name, Grain Size, Principal Constituents, Etc.)	Color	Hardness	Weathering, Bedding, Fracturing, and Other Observations	ROCK
1		S-6	2.0 2.0	1 1		0	SAND, medium-grained, trace silt	Gray	Very loose	wet	
2	12.0		100%								
3		S-7	2.0 2.0	0 0		0	SAND, medium-grained, trace silt	Gray	Very loose	wet	
4	14.0		100%	1							14.0
5							End of boring at 14.0 ft.				
6											
7											
8											
9											
0											

DRILLING CO.: ATEC Associates

DRILLER: M. Miller

BAKER REP.: R. Bowelli

BORING NO.: B-1

SHEET 2 OF 2

laboratory analysis and review. Both field determined USCS soil classification and a soil description shall be included on the log.

5. Depth limits, and the type and number of samples taken.
6. The number of blows required for each six-inch penetration of a split-spoon sampler and for each 12-inch penetration of casing. The percentage of sample recovered, hammer weight, fall length, and hydraulic pressures to push thin-walled tubes.
7. Depth to water as first encountered during drilling operations, along with the method of determination. Any distinct water bearing zones shall also be delineated.
8. Loss of drilling fluid and the interval over which loss occurred.
9. Identification of equipment used, including type of drilling rig, auger types and sizes, etc.
10. Start date and completion dates for the boring.
11. Name of the drilling company and the driller.
12. Size and length of the casing used in each hole.
13. Observations of visual contamination.
14. Field instrument readings (i.e., photoionization detector, organic vapor analyzer).

As the boring is advanced, the inspector shall evaluate the samples and the cuttings to determine the location of each stratigraphic unit. The descriptions should contain color, grain-size, consistency moisture, etc., in addition to the USCS classification category (Section 5.3.7).

Each sample collected for chemical or geotechnical analysis shall be handled as described in SOP #F102.

## **5.2 Soil Classification**

The data shall be recorded on a Field Test Boring Record, or in a field logbook. The method of deriving the classification should be described, or reference made to this SOP or other applicable manuals. Both the soil classification and the soil descriptions must be entered on the Field Test Boring Record. If required, the soil classification shall consist of the two-letter USCS classification; the soil description shall be much more detailed.

Where required, soils will be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Attachment B and identifies soil types on the basis of grain-size and liquid limits, and categorizes them through the use of two letters. Although some laboratory testing is required for full USCS classification, preliminary classifications may be made in the field.

Fine-grained soils are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition; peat is designated by "Pt." Coarse-grained soils are divided into sand (S) or gravel (G). The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

The second letter of the two-letter USCS symbol provides information about the grain size distribution of granular soil, or the plasticity characteristics of fine-grained soils. These second letter modifiers are (P) poorly graded/well sorted, (W) well graded/poorly sorted, (C) clayey, (M) silty, (L) low plasticity, or (H) high plasticity.

### **5.3 Soil Descriptions**

The Test Boring Records shall contain complete soil descriptions in addition to the two-letter USCS classification, if required. Soil descriptions include the following components: grain size identification with descriptive terms indicating the relative percentage of each grain size, color, consistency or relative density, moisture content, organic content, plasticity, and other pertinent observations such as visual contamination, HNu measurements, etc. A summary of the soil description components is given in Attachment C.

### 5.3.1 Grain Size Identification

In nature, soils are comprised of varying size, shape, and combinations of the various grain types. The following terms are used to indicate soil grain size:

<u>Size</u>	<u>Size Limits</u>
Cobbles	3-inches to 12-inches
Coarse gravel	3/4-inches to 3-inches
Fine gravel	4.76 mm (# 4 sieve size) to 3/4-inches
Coarse sand	2 mm (# 10 sieve size) to 4.76 mm
Medium sand	0.42 mm (# 40 sieve size) to 2 mm
Fine sand	0.074 mm (# 200 sieve size) to 0.42 mm
Silt	0.002 mm to 0.074 mm
Clay	less than 0.002 mm

The proportion of each grain size (by weight percent) is indicated using the descriptive terms:

Trace	0 to 10 percent
Little	10 to 20 percent
Some	20 to 35 percent
And (or an adjective form of the grain size, i.e., sandy, silty, clayey)	35 to 50 percent

Some examples of soil grain size descriptions are:

- Silty fine sand: 50 to 65 percent fine sand and 35 to 50 percent silt.
- Medium to coarse sand, some silt: 65 to 90 percent medium to coarse sand, 20 to 35 percent silt.
- Fine sandy silt, trace clay: 50 to 65 percent silt, 35 to 50 percent fine sand, and 0 to 10 percent clay.

The soil type may be classified as noncohesive, granular soils or as cohesive, fine-grained soils as discussed in Section 5.3.3. The grain shape of a soil usually does not need to be determined unless unusual or unique features are readily apparent.

### 5.3.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light-gray" or "blue-gray". Since color can be utilized in correlating units

between sampling locations, it is important for color descriptions to be consistent between borings.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors because sampling devices tend to smear the sample surface creating color variations between interior and exterior.

The term "mottled" shall be used to indicate soil irregularly marked with spots of different colors. Soil color charts shall not be used unless specified by the Project Manager.

### **5.3.3 Relative Density and Consistency**

To classify the relative density and/or consistency of a soil, the drilling inspector first shall identify the soil type. Granular soils contain predominantly sands and gravels. These types of soil are noncohesive (particles do not adhere well when compressed). Conversely, fine-grained soils which contain predominantly silts and clays are cohesive (particles will adhere when compressed).

The density of noncohesive, granular soils or the consistency of cohesive soils is classified according to standard penetration resistances obtained from split barrel sampling performed according to ASTM D-1586. Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a two-inch outside diameter 12-inches into the material using a 140-pound hammer falling freely through 30-inches. In cases where geotechnical information is required, the standard penetration test is performed by driving the sampler through an 18-inch sample interval, the number of blows will then be recorded for each six-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of the sample interval. It is important to note that if gravel and rock fragments are broken by the sampler, or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This must be noted on the Field Test Boring Record and referenced to the sample number. In cases where soil sampling for environmental analytical analysis is required, 24-inch spoon barrels can be used in order to obtain a sufficient quantity of sample for required analysis. Accordingly, the second and third six-inch increments will be used to calculate the relative density.

The relative density designations for noncohesive soils are:

<u>Designation</u>	<u>Standard Penetration Resistance (Blows per Foot)</u>
Very loose	Less than 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Greater than 50

The consistency of cohesive soils is also determined by blow counts as shown:

<u>Designation</u>	<u>Standard Penetration Resistance (Blows per Foot)</u>
Very Soft	Less than 2
Soft	2 to 4
Medium Stiff	4 to 8
Stiff	8 to 15
Very Stiff	15 to 30
Hard	Over 30

#### 5.3.4 Moisture Content

Moisture content is estimated in the field according to four categories: dry, damp, moist, and wet:

<u>Designation</u>	<u>Moisture Content</u>	<u>Descriptive</u>
Dry	0 to 10 percent	Little/no perceptible moisture
Damp	10 to 20 percent	Some perceptible moisture - not compactable
Moist	20 to 35 percent	Compactable
Wet	35 to 50 percent	Above compactable range

Little or no water should appear in dry soil. Wet soils appear to contain all the water they can possibly hold (i.e., saturated). Damp and moist are subjective. Laboratory tests for water content shall be performed if the natural water content is important.

### 5.3.5 Stratification

Stratification can only be determined after the split-barrel sampler is opened. Typically, bedding thicknesses are described as follows:

<u>Designation</u>	<u>Bedding Spacing</u>
Indistinct	No bedding apparent
Laminated	Less than 1/2-inch
Very thin	1/2-inch to 1-inch
Thin	1-inch to 4-inches
Medium	4-inches to 1-foot
Thick	1-foot to 3-feet
Massive	Greater than three feet

### 5.3.6 Texture/Fabric/Bedding

The texture/fabric/bedding of a soil shall be described, where appropriate. Texture is described as the relative angularity of the soil particles: rounded, subrounded, subangular, angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation or orientation. The bedding structure also shall be noted (e.g., stratified, lensatic, nonstratified, heterogeneous varved, etc.).

### 5.3.7 Summary of Soil Descriptions

In summary, soils shall be classified in a similar manner by each drilling inspector. The soil description shall include:

- Soil grain size with appropriate descriptors
- Color
- Relative density and/or consistency
- Moisture content
- Stratification
- Texture/fabric/bedding
- Other distinguishing features

These descriptors are evaluated and the soil classified according the USCS system. All information, measurements and observations shall be legibly recorded on a Field Test Boring Record.

#### 5.4 Sedimentary Rock Classifications

Rocks are grouped into three main divisions: sedimentary, igneous, and metamorphic. Sedimentary rocks are the most predominant type exposed at the earth's surface. As such, this section will consider only classification of sedimentary rocks. Standard geologic references should be used for the complete classification of sedimentary, igneous and metamorphic rocks.

For the purpose of completing the Field Test Boring Record in the field, sedimentary rocks should be classified using the following hierarchy:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Rock Quality Designation
- Weathering
- Other characteristics

##### 5.4.1 Rock Type

There are numerous names for sedimentary rocks such as sandstone, shale, siltstone, claystone, conglomerate, limestone, dolomite, coal, etc. The drilling inspector should select the most appropriate rock type based on experience. Some of the references listed in Section 7.0 provide a more complete discussion of sedimentary rock types.

In addition to selecting a rock type, the drilling inspector should record the grain size (and composition of grains and cement, if apparent) on the Field Test Boring Record. The following designation should be used to describe grain size in sedimentary rocks:

<u>Designation</u>	<u>Grain Size Diameter</u>
Cobbles	Greater than 64 mm (2.5-inches)
Pebbles	4 mm (0.16-inches) to 64 mm
Granules	2 mm (0.08-inches) to 4mm
Very Coarse Sand	1 mm to 2 mm
Coarse Sand	0.5 mm to 1 mm
Medium Sand	0.25 mm to 0.5 mm
Fine Sand	0.125 mm to 0.25 mm
Very Fine Sand	0.0625 mm to 0.125 mm
Silt	0.0039 mm to 0.0625 mm
Clay	Smaller than 0.0039 mm

For individual boundaries of grain size, a scale can be used for coarse-grained rocks. However, the division between silt and clay likely will not be measurable in the field. This boundary shall be determined by use of a hand lens. If the grains cannot be seen with the unaided eye, but are distinguishable with a handlens (5x magnification) the grain size is silt. If the grains are not distinguishable with a handlens, the grain size is clay.

#### **5.4.2 Color**

The color of rock can be determined in a manner similar to that for soil samples. Rock cores or fragments shall be classified while wet, when possible. Rock color charts shall not be used unless specified by the Project Manager.

#### **5.4.3 Bedding Thickness**

The bedding thickness designation for soils (Section 5.3.5) shall also be used for rock descriptions.

#### **5.4.4 Hardness**

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness follows:

- **Very Soft** - Very soft indicates that the rock is easily gouged by a knife, easily scratched by a fingernail, and/or easily broken by hand
- **Soft** - Soft indicates that the rock may be gouged by a knife, scratched by a fingernail, difficult to break by hand, and/or powders when hit by a hammer.
- **Medium Hard** - Medium hard indicates that the rock is easily scratched by a knife and/or is easily broken when hit by a hammer.
- **Hard** - Hard indicates that the rock is difficult to scratch with a knife but may be broken with a hammer.
- **Very Hard** - Very hard indicates that the rock is difficult to break with a hammer.

Note the difference in usage between the words "scratch" and "gouge". A scratch shall be considered a slight depression in the rock while a gouge is much deeper.

#### 5.4.5 Fracturing

The degree of fracturing or brokenness of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is measured and is described by the following terms:

- Very Broken - Less than a two-inch spacing between fractures
- Broken - A two-inch to one-foot spacing between fractures
- Blocky - A one-foot to three-foot spacing between fractures
- Massive - A three-foot to ten-foot spacing between fractures

#### 5.4.6 Rock Quality Designation

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding four inches and dividing by the total length of core run:

$$\text{RQD (\%)} = r/l \times 100$$

Where:

$r$  = Total length of all pieces of the lithologic unit being measured, which are greater than four inches, and have resulted from natural breaks. Natural breaks include slickenslides, joints, compaction slicks, bedding plane partings (not caused by drilling) friable zones, etc.

$l$  = Total length of core run.

The results of the RQD calculations shall be recorded on the Field Test Boring Record.

#### 5.4.7 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and also is useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- Decomposed - Soft to very soft, bedding and fractures indistinct, no cementation.
- Highly weathered - very soft to soft, with medium hard relic rock fragments, little to moderate cementation. Vugs and openings in bedding and fracture planes, some of which may be filled.

- Weathered - Soft to medium hard. Good cementation, bedding and fractures are pronounced. Uniformly stained.
- Slightly weathered - Medium hard. Fractures pronounced, nonuniform staining, bedding distinct.
- Fresh - Medium hard to hard. No staining. Fractures may be present, bedding may or may not be distinct.

#### **5.4.8 Other characteristics**

The following items should be included in rock description, where applicable:

- Description of contacts between rock units (sharp or gradational)
- Stratification
- Description of any filled cavities
- Cementation (calcareous, siliceous, hematitic, etc.)
- Description of joints and open fractures (with strike and dip, if possible)
- Observation of the presence of fossils

#### **5.4.9 Additional Terms**

The following terms also are used to further identify rocks:

- Seam - thin (12-inches or less), probably continuous layer.
- Some - Indicates significant (15 to 40 percent) amounts of an accessory material.
- Few - Indicates insignificant (0 to 15 percent) amounts of an accessory material.
- Interbedded - Indicates thin or very thin alternating seams of material occurring in approximately equal amounts.
- Interlayered - Indicates thick alternating seams of material occurring in approximately equal amounts.

## **6.0 QUALITY ASSURANCE RECORDS**

Quality Assurance Records shall consist of completed Field Test Boring Records and Test Boring Records.

## 7.0 REFERENCES

1. American Society for Testing and Materials, 1990. Standard Methods for Classification of Soils for Engineering Purposes. ASTM Method D2487-90, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.
2. American Society for Testing and Materials, 1990. Standard Practice for Description and Identification of Soils (Visual - Manual Procedure). ASTM Method D2488-90, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

**ATTACHMENT A**

**EXAMPLE TEST BORING RECORD**



# TEST BORING RECORD

PROJECT: Building P-64  
 S.O. NO.: 19010-51-SRN BORING NO.: B-1  
 COORDINATES: EAST: \_\_\_\_\_ NORTH: \_\_\_\_\_  
 ELEVATION: SURFACE: \_\_\_\_\_ TOP OF PVC CASING: \_\_\_\_\_

RIG: Mobile B-57									
	SPLIT SPOON	CASING	AUGERS	CORE BARREL	DATE	PROGRESS (FT)	WEATHER	WATER DEPTH (FT)	TIME
SIZE (DIAM.)	1-3/8" ID		6-1/4" ID		5/31/91	14.0	Sunny, 80°-90°F	---	---
LENGTH	2.0'		5.0'						
TYPE	STD.		HSA						
HAMMER WT.	140#								
FALL	30"								
STICK UP									

REMARKS: Advanced boring to 14 ft. taking continuous 2-foot split-spoon samples; no monitoring well installed - borehole grouted to surface.

SAMPLE TYPE		DEFINITIONS	
S = Split Spoon	A = Auger	SPT = Standard Penetration Test (ASTM D-1586) (Blows/0.5')	
T = Shelby Tube	W = Wash	RQD = Rock Quality Designation (%)	
R = Air Rotary	C = Core	Lab Class. = USCS (ASTM D-2487) or AASHTO (ASTM D-3282)	
D = Denison	P = Piston	Lab Moist. = Moisture Content (ASTM D-2216) Dry Weight Basis	
N = No Sample			

Depth (Ft.)	Sample Type and No.	Sample Rec. Ft. & %	SPT or RQD	Lab. Class. or Pen. Rate	PID (ppm)	Visual Description	Elevation
1			3			TOPSOIL, grass roots; tan, gray; medium dense; dry	1.0'
2	S-1	1.3 2.0 65%	7 9 5		0	SAND, fine-grained, trace gravel, trace silt; tan, brown; loose; moist to damp	
3			4				
4	S-2	1.3 2.0 65%	3 4 4		0	SAND, fine-grained, trace silt, trace grass roots; tan, brown; loose; moist to damp	4.0'
5			11				
6	S-3	2.0 2.0 100%	12 10 8		0	SAND, fine to medium-grained, trace silt; tan, brown, orange; medium dense; moist to wet; water table at 6.0'	
7			3				7.0'
8	S-4	1.8 2.0 90%	4 3 4		0	SAND, medium to coarse-grained, trace silt; tan, gray, orange; loose; wet	
9			1				9.0'
10	S-5	2.0 2.0 100%	0 1 1		0	SAND, medium-grained, trace silt; gray, orange; very loose; wet	

Match to Sheet 2

DRILLING CO.: ATEC Associates  
 DRILLER: M. Miller

BAKER REP.: R. Bonelli  
 BORING NO.: B-1 SHEET 1 OF 2



# TEST BORING RECORD

PROJECT: Building P-64

S.O. NO.: 19010-51-SRN

BORING NO.: B-1

SAMPLE TYPE						DEFINITIONS	
S = Split Spoon	A = Auger					SPT = Standard Penetration Test (ASTM D-1586) (Blows/0.5')	
T = Shelby Tube	W = Wash					RQD = Rock Quality Designation (%)	
R = Air Rotary	C = Core					Lab Class. = USCS (ASTM D-2487) or AASHTO (ASTM D-3282)	
D = Denison	P = Piston					Lab Moist. = Moisture Content (ASTM D-2216) Dry Weight Basis	
N = No Sample							
Depth (Ft.)	Sample Type and No.	Samp. Rec. (Ft. & %)	SPT or RQD	Lab. Class. or Pen. Rate	PID (ppm)	Visual Description	Elevation
11	S-6	2.0 2.0 100%	1		0	SAND, medium-grained, trace silt; gray; very loose; wet	
12			1				
13			0				
14	S-7	2.0 2.0 100%	1		0	SAND, medium-grained, trace silt; gray; very loose; wet	14.0'
14						End of Boring at 14.0'	
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

DRILLING CO.: ATEC Associates

DRILLER: M. Miller

BAKER REP.: R. Bonelli

BORING NO.: B-1

SHEET 2 OF 2

**ATTACHMENT B**

**UNIFIED SOIL CLASSIFICATION SYSTEM**



**ATTACHMENT C**

**SOIL AND ROCK DESCRIPTION SUMMARY**

<u>SOIL DESCRIPTION</u>			<u>ROCK DESCRIPTIONS</u>		
<b><u>GRAIN SIZE IDENTIFICATION</u></b>			<b><u>HARDNESS</u></b>		
<u>NAME</u>	<u>SIZE LIMITS</u>		Very Soft -	Easily gouged by knife, easily scratched by fingernail, easily broken by hand	
Boulder	12" OR MORE		Soft -	Gouged by knife, scratched by fingernail, difficult to break by hand, powders with hammer	
Cobbles	3" - 12"		Medium Hard -	Easily scratched by knife, easily broken with hammer	
Coarse Gravel	3/4" - 3"		Hard -	Difficult to scratch, breaks with hammer	
Fine Gravel	4.76 mm (#4) - 3/4"		Very Hard -	Difficult to break, rings when struck	
Coarse Sand	2 mm (#10) - 4.76 mm (#4)				
Medium Sand	0.42 mm (#40) - 2 mm (#10)				
Fine Sand	0.074 mm (#200)-0.42 mm (#40)				
Silt	0.002 mm-0.074 mm (#200)				
Clay	Less than 0.002 mm				
<b><u>RELATIVE DENSITY</u></b>			<b><u>WEATHERING</u></b>		
<b><u>NONCOHESIVE SOIL</u></b>			Decomposed -	Soft to Very soft, bedding and fractures indistinct, no cementation.	
<u>TERM</u>	<u>SPT (Blows/ft)</u>		Highly Weathered -	Very soft to soft, with medium hard relict rock fragments: little to moderate cementation. Vugs, openings in bedding and fractures (may be filled).	
Very Loose	Below 4		Weathered -	Soft to medium hard. Good cementation, bedding and fractures are pronounced. Uniformly stained.	
Loose	4-10		Slightly Weathered -	Medium hard. Fractures pronounced, non-uniform staining, bedding distinct.	
Medium Dense	10-30		Fresh -	Medium hard to hard. No staining. Fractures may be present. Bedding may or may not be indistinct.	
Dense	30-50				
Very Dense	OVER 50				
<b><u>COHESIVE SOILS</u></b>			<b><u>BEDDING AND FRACTURES:</u></b>		
<u>TERM</u>	<u>SPT (Blows/ft)</u>		<u>SPACING</u>	<u>BEDDING</u>	<u>FRACTURES</u>
Very Soft	BELOW 2		LESS THAN 1/2" (1 cm)	Indistinct	Fissile
Soft	2-4		1/2" to 1" (1cm-3cm)	Laminated	Very Close
Medium Stiff	4-8		1" TO 4" (3cm-10cm)	Very Thin	Close
Stiff	8-15		4" TO 1' (10cm-30cm)	Thin	Moderate
Very Stiff	15-30		1' TO 3' (30 cm-1m)	Moderate	Wide
Hard	OVER 30		3' TO 10' (1m-3m)	Thick	Very Wide
				Massive	
<b><u>MOISTURE</u></b>					
	<b><u>DESCRIPTIVE TERMS</u></b>				
Dry -	Trace	0-10%			
Damp	Little	10-20%			
Moist	Some	20-35%			
Wet	And	35-50%			
<b><u>CONTACTS:</u></b>			<b><u>SAMPLE TYPE</u></b>		
_____ = DEFINITE			S = Split Spoon	HS = Hollow Stem	
_____ = INDEFINITE			T = Shelby Tube	NP = Non Plastic	
..... = GRADATIONAL			R = Air Rotary	-PL = Below the Plastic Limit	
			D = Denison	PL = At the Plastic Limit	
			A = Auger	+ PL = Above the Plastic Limit	
			W = Wash (Roller Bit)	+ LL = Above the Liquid Limit	
			C = Core	SPT = Standard Penetration Test	
			P = Piston	RQD = Rock Quality Designation	
			N = No Sample Taken		

ROCK SYMBOLS

	CONGLOMERATE		LIMESTONE
	BRECCIA		DOLOMITE
	SANDSTONE		COAL
	SILTSTONE		VOID
	SHALE		UNDIFFERENTIATED
	CLAYSTONE		

HARDNESS

- V. SOFT - CORE RECOVERY < 50%, EASILY GOUGED BY KNIFE OR SCREWDRIVER, EASILY SCRATCHED BY FINGERNAIL, EASILY BROKEN BY HAND
- SOFT - CORE RECOVERY 50 - 75%, GOUGED BY KNIFE OR SCREWDRIVER, SCRATCHED BY FINGERNAIL, DIFFICULT TO BREAK BY HAND, POWDERS w/HAMMER
- MED. HD. - CORE RECOVERY > 75%, EASILY SCRATCHED BY KNIFE OR SCREWDRIVER, EASILY BROKEN BY HAMMER
- HD. - DIFFICULT TO SCRATCH, BREAKS w/HAMMER
- V. HD. - DIFFICULT TO BREAK, RINGS WHEN STRUCK

SPACING

- LESS THAN 1/4" (1cm)
- 1/4" To 1" (1cm-3cm)
- 1" To 4" (3cm-10cm)
- 4" To 1' (10cm-30cm)
- 1' To 3' (30cm-1m)
- 3' To 10' (1m-2m)

BEDDING

- INDISTINCT
- LAMINATED
- VERY THIN
- THIN
- MODERATE
- THICK
- MASSIVE

FRACTURES

- FISSILE
- VERY CLOSE
- CLOSE
- MODERATE
- WIDE
- VERY WIDE

WEATHERING

- DECOMPOSED - SOFT - V. SOFT, BEDDING AND FRACTURES INDISTINCT, NO CEMENTATION
- HL WTHR. - V. SOFT - SOFT, w/MED. HD. RELICT ROCK FRAGMENTS; LITTLE TO MOD. CEMENTATION, VUGS, OPENINGS IN BEDDING AND FRACTURES (MAY BE CLAY OR CALC. FILLED)
- WTHR. - SOFT TO MED. HD., GOOD CEMENTATION, BEDDING AND FRACTURES ARE PRONOUNCED, UNIFORMLY STAINED
- SL WTHR. - MED. HD., FRACTURES PRONOUNCED, NON-UNIFORM STAINING, BEDDING DISTINCT
- FRESH - MED. HD. TO HD., NO STAINING, FRACTURES MAY BE PRESENT, BEDDING MAY OR MAY NOT BE DISTINCT

COMMON LOCAL SEDIMENTARY ROCK CLASSIFICATIONS

MM APP. SIEVE SIZE	NO FIZZ			SLIGHT FIZZ		RAPID FIZZ		% SILICATE
				% CARBONATE				
2.0	CONGLOMERATE - If particles rounded BRECCIA - If particles angular; classify both particles and matrix as below							
VERY COARSE GRAINED		SANDSTONE	CALCAREOUS SANDSTONE	ARENACEOUS LIMESTONE	LIMESTONE			
COARSE GRAINED								
MEDIUM GRAINED								
FINE GRAINED								
VERY FINE GRAINED								
.005	SILTSTONE SHALE (IF LAM OR FIS.)	CALC. SILTSTONE CALC. SHALE (MARL)	SILTY LIMESTONE (ARG)	CRYSTALLINE			SLIGHTLY VISIBLE GRITTY	
	CLAYSTONE	CALC. CLAYSTONE	CLAYEY LIMESTONE				NOT VISIBLE SMOOTH	

$ROD = \frac{L}{R}$  - NTYPE CORE ONLY

L = TOTAL LENGTH IN A RUN OF CORE PIECES LONGER THAN 4"

R = LENGTH OF THE RUN

ROCK DESCRIPTIONS



## Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)<sup>1</sup>

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.*

### 1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

D 653 Terminology Relating to Soil, Rock, and Contained Fluids<sup>2</sup>

D 1452 Practice for Soil Investigation and Sampling by Auger Borings<sup>2</sup>

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils<sup>2</sup>

D 1587 Practice for Thin-Walled Tube Sampling of Soils<sup>2</sup>

D 2113 Practice for Diamond Core Drilling for Site Investigation<sup>2</sup>

D 2487 Test Method for Classification of Soils for Engineering Purposes<sup>2</sup>

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)<sup>2</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

*Cobbles*—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

*Boulders*—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75- $\mu$ m) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

*coarse*—passes a 3-in. (75-mm) sieve and is retained on a 3/4-in. (19-mm) sieve.

*fine*—passes a 3/4-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No. 4

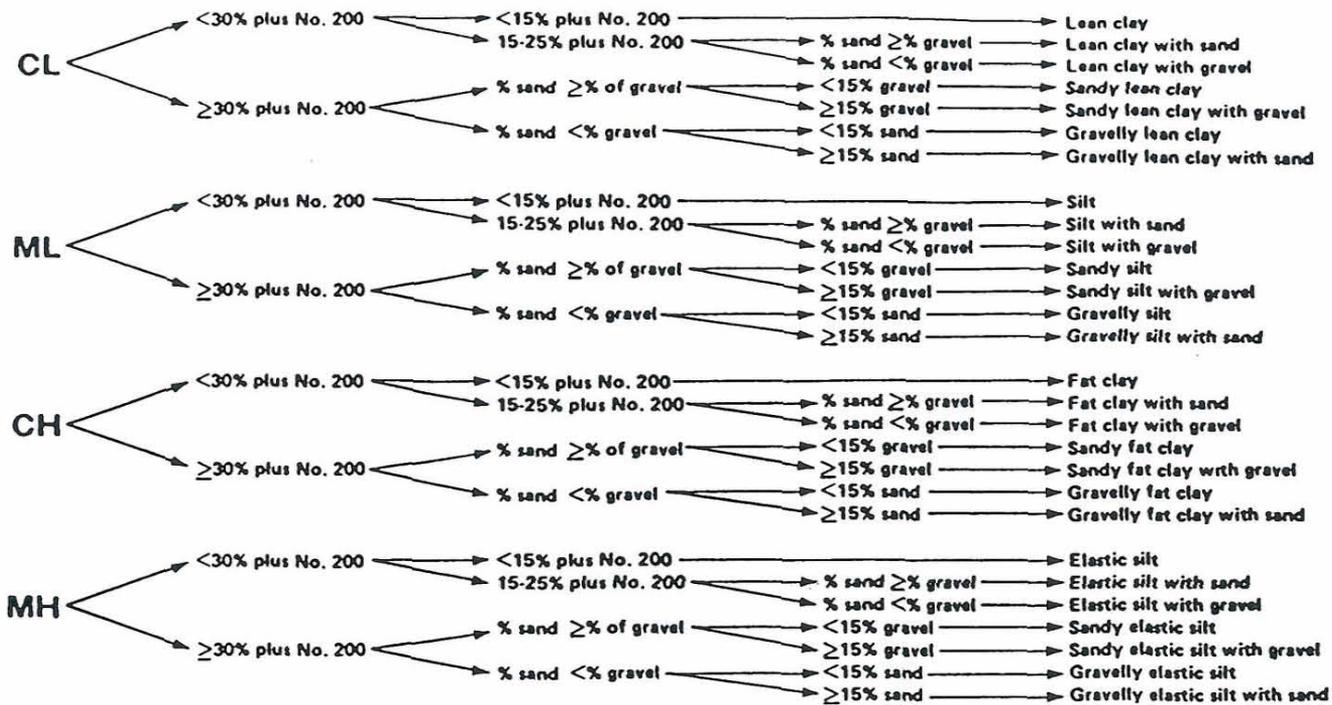
<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 04.08.

GROUP SYMBOL

GROUP NAME



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5%.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50% or more fines)

75-μm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

- coarse*—passes a No. 4 (4.75-mm) sieve and is retained on No. 10 (2.00-mm) sieve.
- medium*—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.
- fine*—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no shrinkage when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the “A” line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

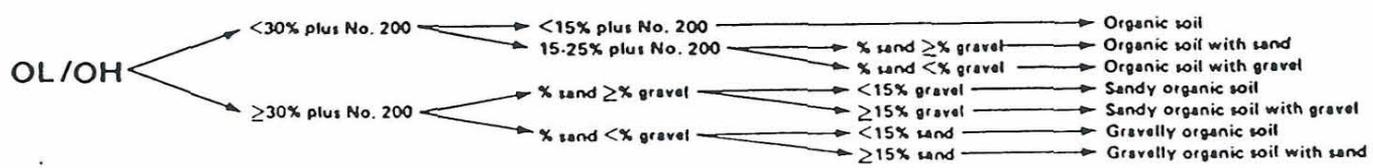
4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

*Dual Symbol*—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12% fines or

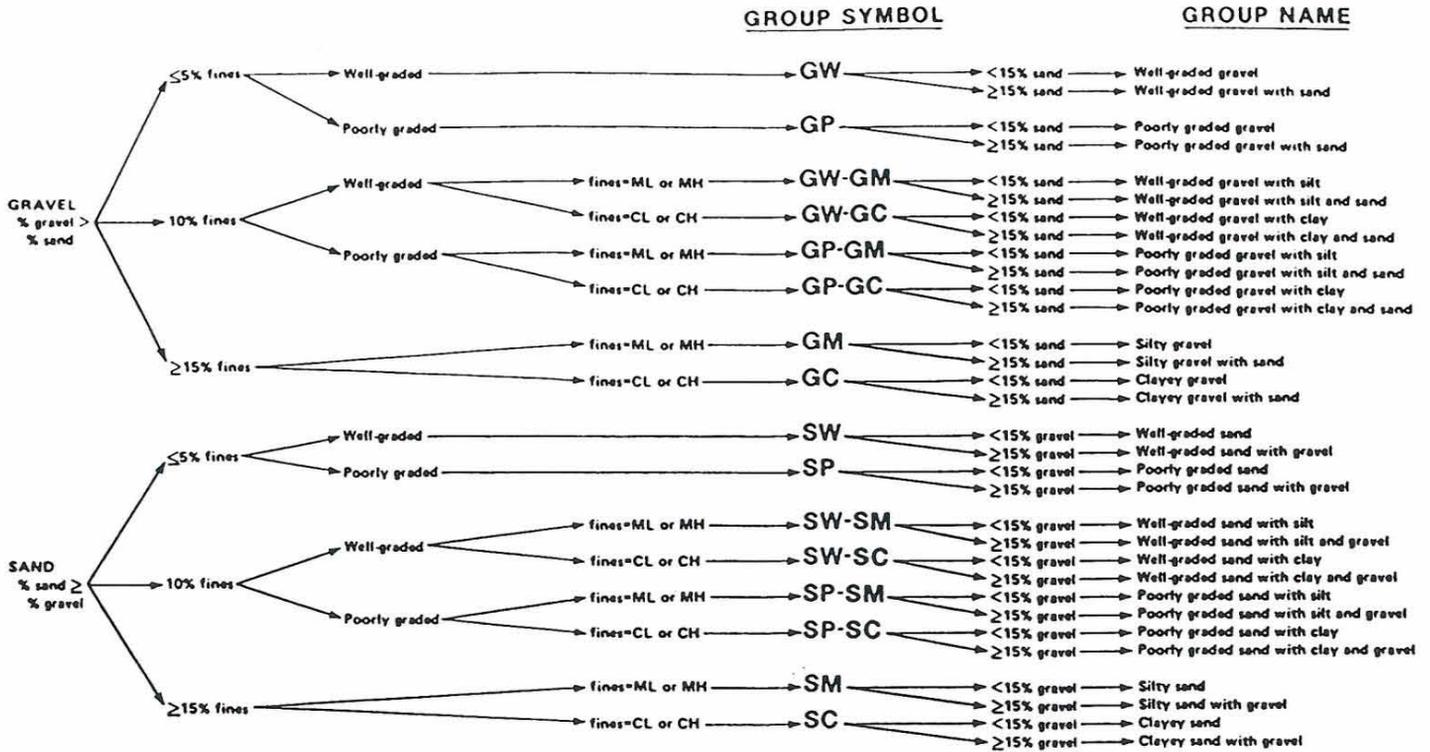
GROUP SYMBOL

GROUP NAME



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5%.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50% or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5%.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

**Borderline Symbol**—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

### 5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test

results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

### 6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

6.2.1 *Small Test Tube and Stopper (or jar with a lid).*

6.2.2 *Small Hand Lens.*

### 7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 N) to three parts water (This reagent is optional for use with this practice). See Section 8.

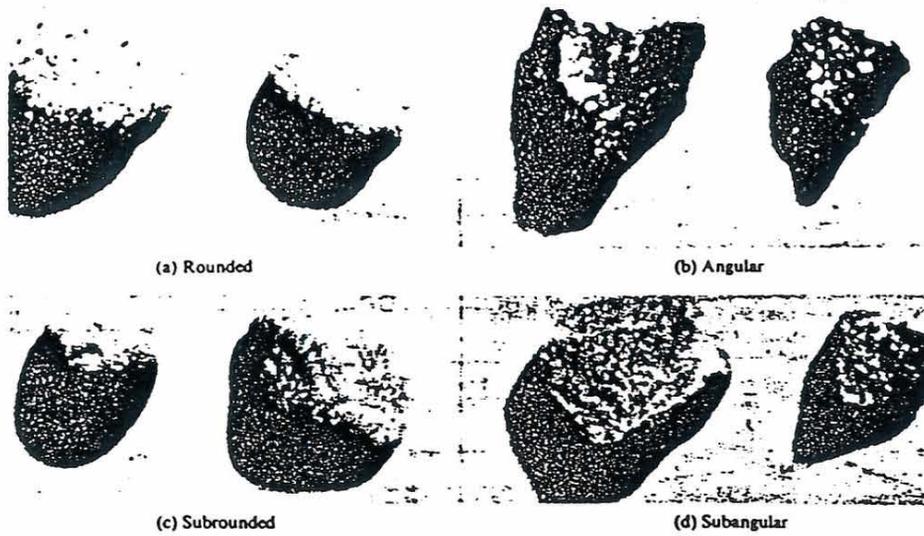


FIG. 3 Typical Angularity of Bulky Grains

**Safety Precautions**

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 N) to three parts of still water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If contact comes into contact with the skin, rinse thoroughly with water.

8.2 Caution—Do not add water to acid.

**Sampling**

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.5 lb)
9.5 mm (3/8 in.)	200 g (0.5 lb)
19.0 mm (3/4 in.)	1.0 kg (2.2 lb)
38.1 mm (1 1/2 in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

**10. Descriptive Information for Soils**

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

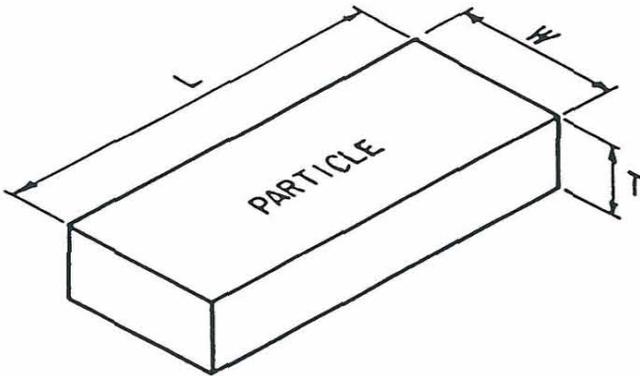
TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

PARTICLE SHAPE

W = WIDTH  
T = THICKNESS  
L = LENGTH



FLAT:  $W/T > 3$   
ELONGATED:  $L/W > 3$   
FLAT AND ELONGATED:  
- meets both criteria

FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the criteria in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about 1/4 in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1 1/2 in. (will pass a 1 1/2-in. square opening but not a 3/4-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation.

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fractured	Breaks along definite planes of fracture with little resistance to fracturing
Wickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Mottled	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

ation of the soil, or both, may be added if identified as such.  
 10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more

fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 Dry Strength:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about 1/2 in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about 1/2 in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accordance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 Dilatancy:

14.3.1 From the specimen, select enough material to mold into a ball about 1/2 in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 Toughness:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about 1/8 in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 in. The thread will crumble at a diameter of 1/8 in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 Plasticity—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an inorganic or an organic fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 Identification of Inorganic Fine-Grained Soils:

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A 1/8-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a lean clay, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a fat clay, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a silt, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an elastic silt, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 Identification of Organic Fine-Grained Soils:

14.8.1 Identify the soil as an organic soil, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a gravel if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

TABLE 13 Checklist for Description of Soils

1. Group name	
2. Group symbol	
3. Percent of cobbles or boulders, or both (by volume)	
4. Percent of gravel, sand, or fines, or all three (by dry weight)	
5. Particle-size range:	Gravel—fine, coarse Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded	
7. Particle shape: (if appropriate) flat, elongated, flat and elongated	
8. Maximum particle size or dimension	
9. Hardness of coarse sand and larger particles	
10. Plasticity of fines: nonplastic, low, medium, high	
11. Dry strength: none, low, medium, high, very high	
12. Dilatancy: none, slow, rapid	
13. Toughness: low, medium, high	
14. Color (in moist condition)	
15. Odor (mention only if organic or unusual)	
16. Moisture: dry, moist, wet	
17. Reaction with HCl: none, weak, strong	
<i>For intact samples:</i>	
18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard	
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous	
20. Cementation: weak, moderate, strong	
21. Local name	
22. Geologic interpretation	
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.	

reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

*Trace*—Particles are present but estimated to be less than 5 %

*Few*—5 to 10 %

*Little*—15 to 25 %

*Some*—30 to 45 %

*Mostly*—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, M).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, C" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

5. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—about 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak

APPENDIXES

(Nonmandatory Information)

XI. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

*In-Place Conditions*—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray;

in-place density 106 lb/ft<sup>3</sup>; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incorporated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to

100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as “Sandy Lean Clay (CL)”; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; “Poorly Graded Sand with Silt (SP-SM)”; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; “Poorly Graded Gravel with Sand (GP).”

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; “Poorly Graded Gravel (GP)”; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two

possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the

percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-

grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay  
ML/CL clayey silt  
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

#### X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory terminations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size

present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

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## Standard Test Method for Classification of Soils for Engineering Purposes<sup>1</sup>

This standard is issued under the fixed designation D 2487; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This test method has been approved for use by agencies of the Department of Defense. Consult the DOD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.*

### 1. Scope

1.1 This test method describes a system for classifying mineral and organo-mineral soils for engineering purposes based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index and shall be used when precise classification is required.

NOTE 1—Use of this standard will result in a single classification group symbol and group name except when a soil contains 5 to 12 % fines or when the plot of the liquid limit and plasticity index values falls into the crosshatched area of the plasticity chart. In these two cases, a dual symbol is used, for example, GP-GM, CL-ML. When the laboratory test results indicate that the soil is close to another soil classification group, the borderline condition can be indicated with two symbols separated by a slash. The first symbol should be the one based on this standard, for example, CL/CH, GM/SM, SC/CL. Borderline symbols are particularly useful when the liquid limit value of clayey soils is close to 50. These soils can have expansive characteristics and the use of a borderline symbol (CL/CH, CH/CL) will alert the user of the assigned classifications of expansive potential.

1.2 The group symbol portion of this system is based on laboratory tests performed on the portion of a soil sample passing the 3-in. (75-mm) sieve (see Specification E 11).

1.3 As a classification system, this test method is limited to naturally occurring soils.

NOTE 2—The group names and symbols used in this test method may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. See Appendix X2.

1.4 This test method is for qualitative application only.

NOTE 3—When quantitative information is required for detailed designs of important structures, this test method must be supplemented by laboratory tests or other quantitative data to determine performance characteristics under expected field conditions.

1.5 The system is based on the widely recognized Unified Soil Classification System which was adopted by several U.S. Government agencies in 1952 as an outgrowth of the Airfield Classification System developed by A. Casagrande.<sup>2</sup>

1.6 *This standard does not purport to address the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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<sup>2</sup> Casagrande, A., "Classification and Identification of Soils," *Transactions*, ASCE, 1948, p. 901.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- C 117 Test Method for Materials Finer Than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing<sup>3</sup>
- C 136 Method for Sieve Analysis of Fine and Coarse Aggregates<sup>3</sup>
- C 702 Practice for Reducing Field Samples of Aggregate to Testing Size<sup>3</sup>
- D 420 Practice for Investigating and Sampling Soil and Rock for Engineering Purposes<sup>4</sup>
- D 421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants<sup>4</sup>
- D 422 Method for Particle-Size Analysis of Soils<sup>4</sup>
- D 653 Terminology Relating to Soil, Rock, and Contained Fluids<sup>4</sup>
- D 1140 Test Method for Amount of Material in Soils Finer than the No. 200 (75- $\mu$ m) Sieve<sup>4</sup>
- D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures<sup>4</sup>
- D 2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants<sup>4</sup>
- D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)<sup>4</sup>
- D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)<sup>4</sup>
- D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils<sup>4</sup>
- D 4427 Classification of Peat Samples by Laboratory Testing<sup>4</sup>
- E 11 Specification for Wire-Cloth Sieves for Testing Purposes<sup>3</sup>

### 3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terms and Symbols D 653.

NOTE 4—For particles retained on a 3-in. (75-mm) U.S. standard sieve, the following definitions are suggested:

*Cobbles*—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) U.S. standard sieve, and

*Boulders*—particles of rock that will not pass a 12in. (300-mm) square opening

3.1.1 *gravel*—particles of rock that will pass a 3-in.

<sup>3</sup> Annual Book of ASTM Standards, Vol 04.02.

<sup>4</sup> Annual Book of ASTM Standards, Vol 04.08.

75-mm) sieve and be retained on a No. 4 (4.75-mm) U.S. standard sieve with the following subdivisions:

*Coarse*—passes 3-in. (75-mm) sieve and retained on ¾-in. (19-mm) sieve, and

*Fine*—passes ¾-in. (19-mm) sieve and retained on No. 4 (4.75-mm) sieve.

3.1.2 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-µm) U.S. standard sieve with the following subdivisions:

*Coarse*—passes No. 4 (4.75-mm) sieve and retained on No. 10 (2.00-mm) sieve,

*Medium*—passes No. 10 (2.00-mm) sieve and retained on No. 40 (425-µm) sieve, and

*Fine*—passes No. 40 (425-µm) sieve and retained on No. 200 (75-µm) sieve.

3.1.3 *clay*—soil passing a No. 200 (75-µm) U.S. standard sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents and that exhibits considerable strength when air dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line.

3.1.4 *silt*—soil passing a No. 200 (75-µm) U.S. standard sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4 or if the plot of plasticity index versus liquid limit falls below the "A" line.

3.1.5 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.6 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.7 *peat*—a soil composed of vegetable tissue in various stages of decomposition usually with an organic odor, a dark-brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.2 *Descriptions of Terms Specific to This Standard:*

3.2.1 *coefficient of curvature, C<sub>c</sub>*—the ratio  $(D_{30})^2 / (D_{10} \times D_{60})$ , where  $D_{60}$ ,  $D_{30}$ , and  $D_{10}$  are the particle diameters corresponding to 60, 30, and 10 % finer on the cumulative particle-size distribution curve, respectively.

3.2.2 *coefficient of uniformity, C<sub>u</sub>*—the ratio  $D_{60} / D_{10}$ , where  $D_{60}$  and  $D_{10}$  are the particle diameters corresponding to 60 and 10 % finer on the cumulative particle-size distribution curve, respectively.

4. Summary of Test Method

4.1 As illustrated in Table 1, this classification system identifies three major soil divisions: coarse-grained soils, fine-grained soils, and highly organic soils. These three divisions are further subdivided into a total of 15 basic soil groups.

4.2 Based on the results of visual observations and prescribed laboratory tests, a soil is catalogued according to the basic soil groups, assigned a group symbol(s) and name, and

thereby classified. The flow charts, Fig. 1 for fine-grained soils, and Fig. 2 for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name.

5. Significance and Use

5.1 This test method classifies soils from any geographic location into categories representing the results of prescribed laboratory tests to determine the particle-size characteristics, the liquid limit, and the plasticity index.

5.2 The assigning of a group name and symbol(s) along with the descriptive information required in Practice D 2488 can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.3 The various groupings of this classification system have been devised to correlate in a general way with the engineering behavior of soils. This test method provides a useful first step in any field or laboratory investigation for geotechnical engineering purposes.

5.4 This test method may also be used as an aid in training personnel in the use of Practice D 2488.

5.5 This test method may be used in combination with Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 In addition to the apparatus that may be required for obtaining and preparing the samples and conducting the prescribed laboratory tests, a plasticity chart, similar to Fig. 3, and a cumulative particle-size distribution curve, similar to Fig. 4, are required.

NOTE 5—The "U" line shown on Fig. 3 has been empirically determined to be the approximate "upper limit" for natural soils. It is a good check against erroneous data, and any test results that plot above or to the left of it should be verified.

7. Sampling

7.1 Samples shall be obtained and identified in accordance with a method or methods, recommended in Recommended Practice D 420 or by other accepted procedures.

7.2 For accurate identification, the minimum amount of test sample required for this test method will depend on which of the laboratory tests need to be performed. Where only the particle-size analysis of the sample is required, specimens having the following minimum dry weights are required:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (¾ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

Whenever possible, the field samples should have weights two to four times larger than shown.

7.3 When the liquid and plastic limit tests must also be performed, additional material will be required sufficient to provide 150 g to 200 g of soil finer than the No. 40 (425-µm) sieve.

7.4 If the field sample or test specimen is smaller than the minimum recommended amount, the report shall include an appropriate remark.

TABLE 1 Soil Classification Chart

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>A</sup>				Soil Classification	
				Group Symbol	Group Name <sup>B</sup>
Coarse-Grained Soils More than 50 % retained on No. 200 sieve	Gravels More than 50 % of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5 % fines <sup>C</sup>	$Cu \geq 4$ and $1 \leq Cc \leq 3^E$	GW	Well-graded gravel <sup>F</sup>
			$Cu < 4$ and/or $1 > Cc > 3^E$	GP	Poorly graded gravel <sup>F</sup>
		Gravels with Fines More than 12 % fines <sup>C</sup>	Fines classify as ML or MH	GM	Silty gravel <sup>F,G,H</sup>
		Fines classify as CL or CH	GC	Clayey gravel <sup>F,G,H</sup>	
	Sands 50 % or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5 % fines <sup>D</sup>	$Cu \geq 6$ and $1 \leq Cc \leq 3^E$	SW	Well-graded sand
			$Cu < 6$ and/or $1 > Cc > 3^E$	SP	Poorly graded sand <sup>I</sup>
Sands with Fines More than 12 % fines <sup>D</sup>		Fines classify as ML or MH	SM	Silty sand <sup>G,H,I</sup>	
	Fines classify as CL or CH	SC	Clayey sand <sup>G,H,I</sup>		
Fine-Grained Soils 50 % or more passes the No. 200 sieve	Silt and Clays Liquid limit less than 50	Inorganic	$Pi > 7$ and plots on or above "A" line <sup>J</sup>	CL	Lean clay <sup>K,L,M</sup>
			$Pi < 4$ or plots below "A" line <sup>J</sup>	ML	Silt <sup>K,L,M</sup>
		organic	$\frac{\text{Liquid limit} - \text{oven dried}}{\text{Liquid limit} - \text{not dried}} < 0.75$	OL	Organic clay <sup>K,L,M,N</sup> Organic silt <sup>K,L,M,O</sup>
	Silt and Clays Liquid limit 50 or more	Inorganic	$Pi$ plots on or above "A" line	CH	Fat clay <sup>K,L,M</sup>
			$Pi$ plots below "A" line	MH	Elastic silt <sup>K,L,M</sup>
		organic	$\frac{\text{Liquid limit} - \text{oven dried}}{\text{Liquid limit} - \text{not dried}} < 0.75$	OH	Organic clay <sup>K,L,M,P</sup> Organic silt <sup>K,L,M,O</sup>
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

<sup>A</sup> Based on the material passing the 3-in. (75-mm) sieve.

<sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

<sup>C</sup> Gravels with 5 to 12 % fines require dual symbols:  
 GW-GM well-graded gravel with silt  
 GW-GC well-graded gravel with clay  
 GP-GM poorly graded gravel with silt  
 GP-GC poorly graded gravel with clay

<sup>D</sup> Sands with 5 to 12 % fines require dual symbols:  
 SW-SM well-graded sand with silt  
 SW-SC well-graded sand with clay  
 SP-SM poorly graded sand with silt  
 SP-SC poorly graded sand with clay

<sup>E</sup>  $Cu = D_{60}/D_{10}$        $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

<sup>F</sup> If soil contains  $\geq 15$  % sand, add "with sand" to group name.

<sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

<sup>H</sup> If fines are organic, add "with organic fines" to group name.

<sup>I</sup> If soil contains  $\geq 15$  % gravel, add "with gravel" to group name.

<sup>J</sup> If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

<sup>K</sup> If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.

<sup>L</sup> If soil contains  $\geq 30$  % plus No. 200, predominantly sand, add "sandy" to group name.

<sup>M</sup> If soil contains  $\geq 30$  % plus No. 200, predominantly gravel, add "gravelly" to group name.

<sup>N</sup>  $Pi \geq 4$  and plots on or above "A" line.

<sup>O</sup>  $Pi < 4$  or plots below "A" line.

<sup>P</sup>  $Pi$  plots on or above "A" line.

<sup>Q</sup>  $Pi$  plots below "A" line.

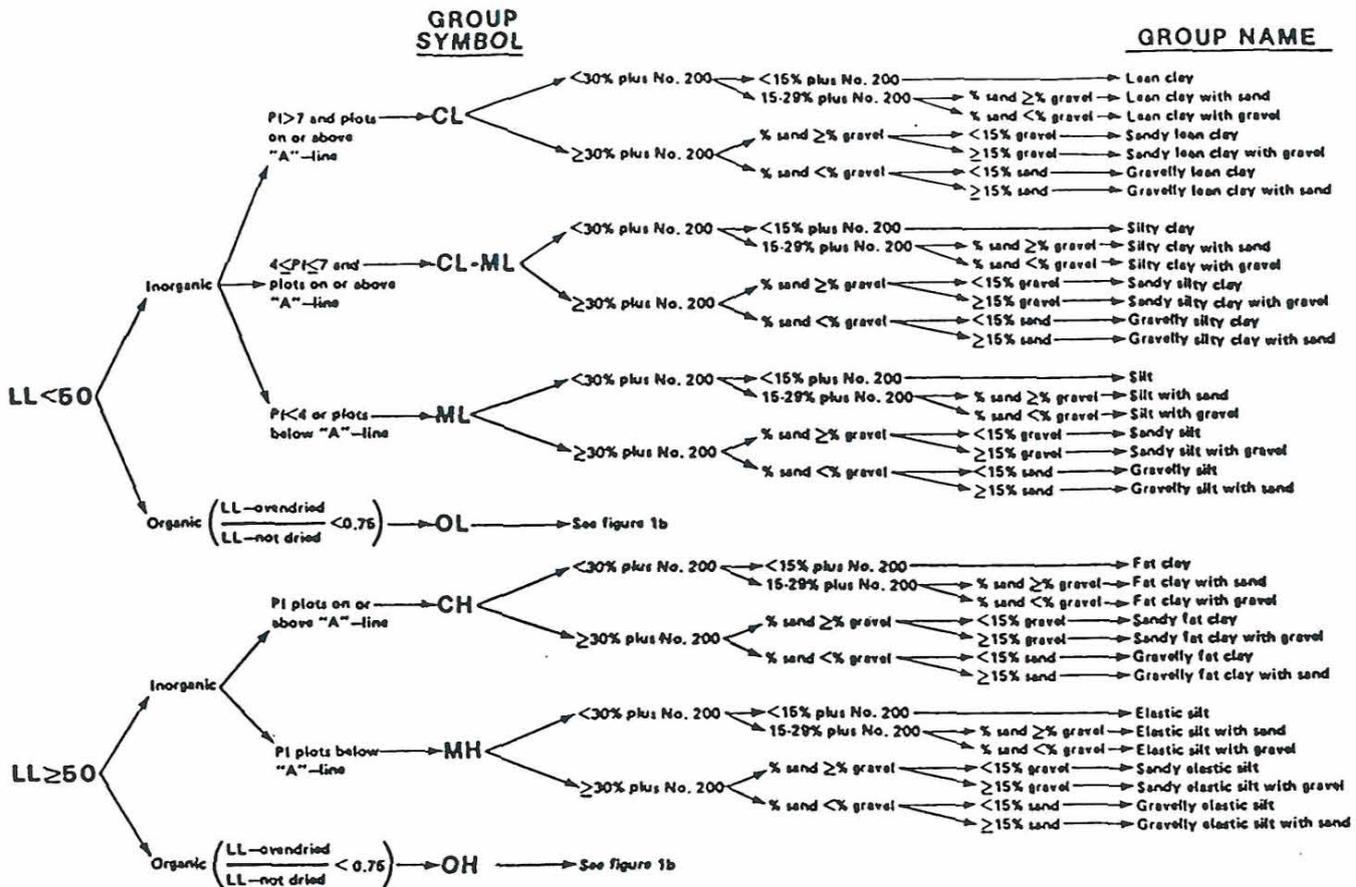


FIG. 1a Flow Chart for Classifying Fine-Grained Soil (50 % or More Passes No. 200 Sieve)

8. Classification of Peat

8.1 A sample composed primarily of vegetable tissue in various stages of decomposition and has a fibrous to amorphous texture, a dark-brown to black color, and an organic odor should be designated as a highly organic soil and shall be classified as peat, PT, and not subjected to the classification procedures described hereafter.

8.2 If desired, classification of type of peat can be performed in accordance with Classification D 4427.

9. Preparation for Classification

9.1 Before a soil can be classified according to this test method, generally the particle-size distribution of the minus 3-in. (75-mm) material and the plasticity characteristics of the minus No. 40 (425-μm) sieve material must be determined. See 9.8 for the specific required tests.

9.2 The preparation of the soil specimen(s) and the testing for particle-size distribution and liquid limit and plasticity index shall be in accordance with accepted standard procedures. Two procedures for preparation of the soil specimens for testing for soil classification purposes are given in appendixes X3 and X4. Appendix X3 describes the wet preparation method and is the preferred method for cohesive soils that have never dried out and for organic soils.

9.3 When reporting soil classifications determined by this test method, the preparation and test procedures used shall be reported or referenced.

9.4 Although the test procedure used in determining the particle-size distribution or other considerations may require a hydrometer analysis of the material, a hydrometer analysis is not necessary for soil classification.

9.5 The percentage (by dry weight) of any plus 3-in. (75-mm) material must be determined and reported as auxiliary information.

9.6 The maximum particle size shall be determined (measured or estimated) and reported as auxiliary information.

9.7 When the cumulative particle-size distribution is required, a set of sieves shall be used which include the following sizes (with the largest size commensurate with the maximum particle size) with other sieve sizes as needed or required to define the particle-size distribution:

- 3-in. (75-mm)
- ¾-in. (19.0-mm)
- No. 4 (4.75-mm)
- No. 10 (2.00-mm)
- No. 40 (425-μm)
- No. 200 (75-μm)

9.8 The tests required to be performed in preparation for classification are as follows:

9.8.1 For soils estimated to contain less than 5 % fines, a plot of the cumulative particle-size distribution curve of the fraction coarser than the No. 200 (75-μm) sieve is required. The cumulative particle-size distribution curve may be plotted on a graph similar to that shown in Fig. 4.

GROUP SYMBOL

GROUP NAME

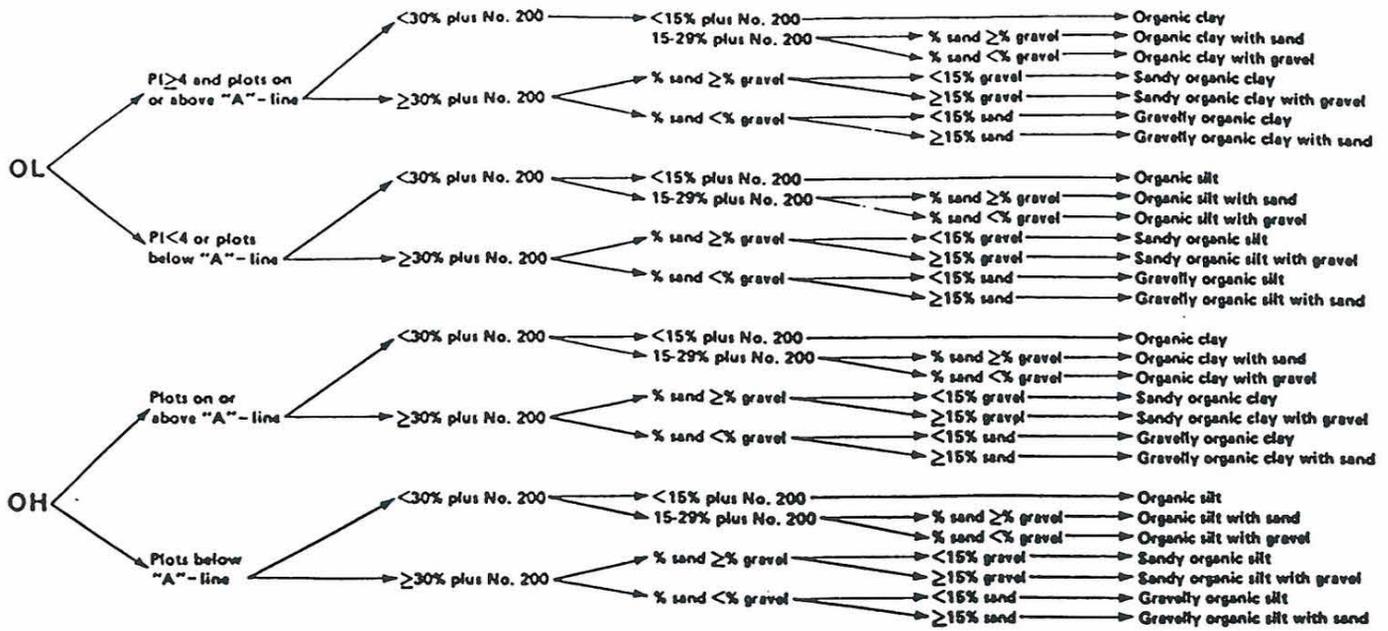


FIG. 1b Flow Chart for Classifying Organic Fine-Grained Soil (50 % or More Passes No. 200 Sieve)

GROUP SYMBOL

GROUP NAME

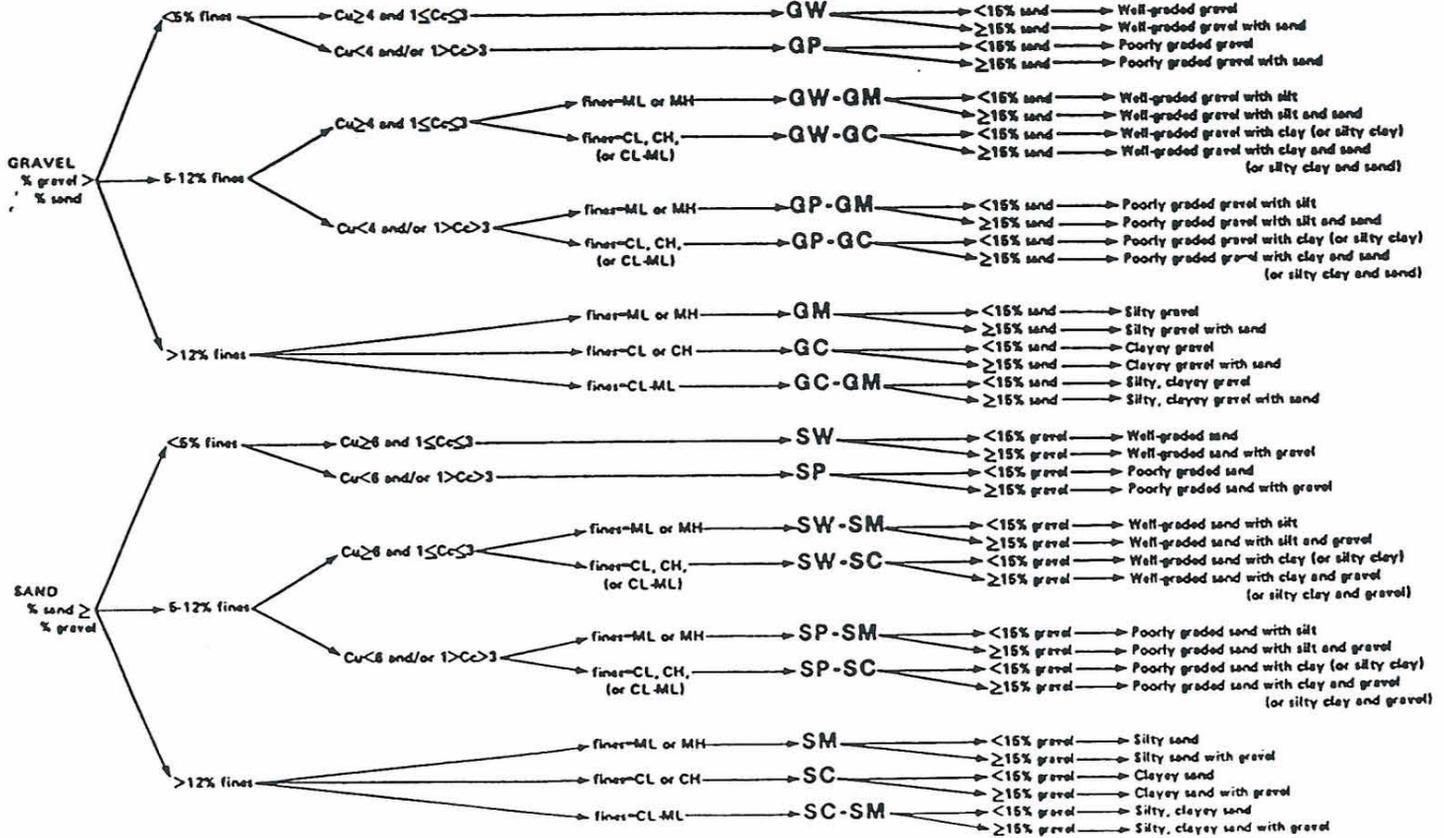


FIG. 2 Flow Chart for Classifying Coarse-Grained Soils (More Than 50 % Retained on No. 200 Sieve)

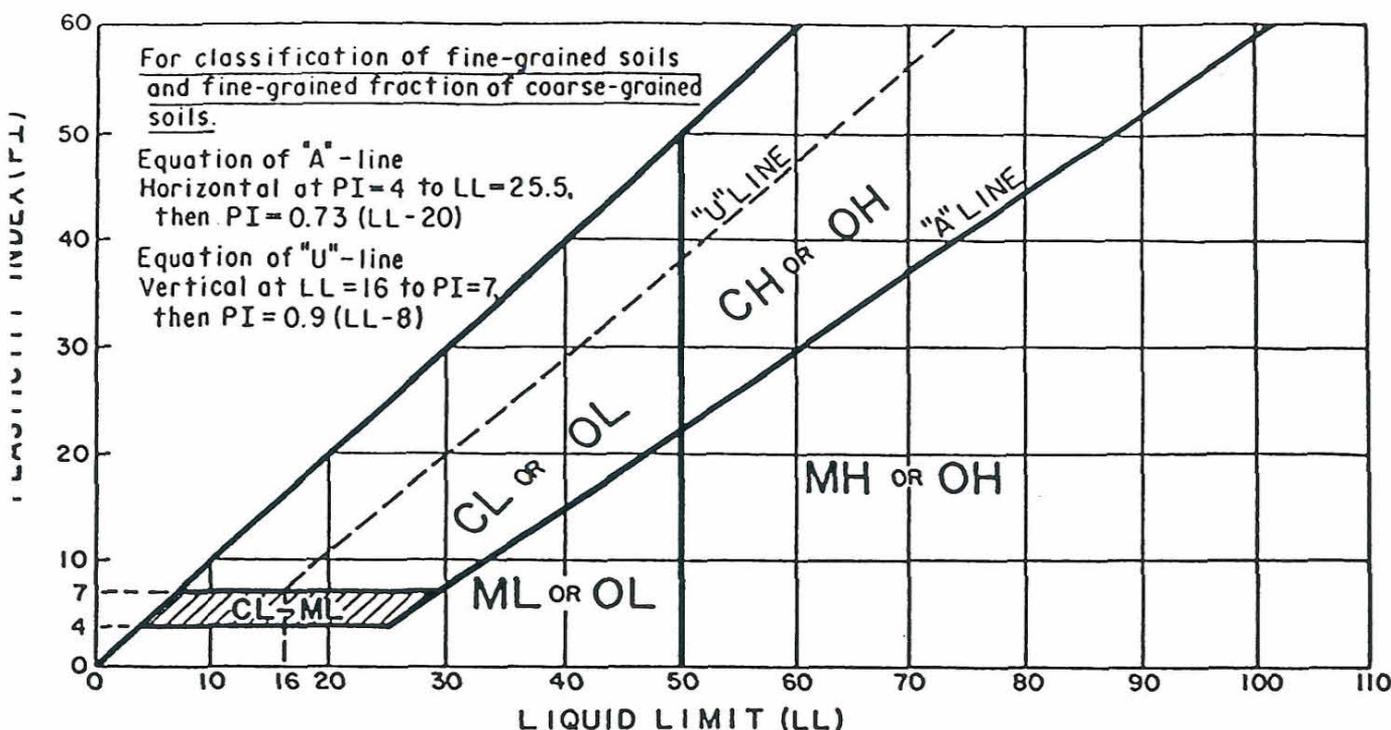


FIG. 3 Plasticity Chart

11.2 For soils estimated to contain 5 to 15 % fines, a relative particle-size distribution curve, as described in 11.1, is required, and the liquid limit and plasticity index are required.

11.2.1 If sufficient material is not available to determine liquid limit and plasticity index, the fines should be estimated to be either silty or clayey using the procedures described in Practice D 2488 and so noted in the report.

11.2.2 For soils estimated to contain 15 % or more fines, a determination of the percent fines, percent sand, and percent gravel is required, and the liquid limit and plasticity index are required. For soils estimated to contain 90 % or more fines, the percent fines, percent sand, and percent gravel shall be estimated using the procedures described in Practice D 2488 and so noted in the report.

**Preliminary Classification Procedure**

11.0.1 Class the soil as fine-grained if 50 % or more by dry weight of the test specimen passes the No. 200 (75- $\mu$ m) sieve and follow Section 11.

11.0.2 Class the soil as coarse-grained if more than 50 % by weight of the test specimen is retained on the No. 200 (75- $\mu$ m) sieve and follow Section 12.

**Procedure for Classification of Fine-Grained Soils (50 % or more by dry weight passing the No. 200 (75- $\mu$ m) sieve)**

11.1 The soil is an inorganic clay if the position of the plasticity index versus liquid limit plot, Fig. 3, falls on or above the "A" line, the plasticity index is greater than 4, and presence of organic matter does not influence the liquid limit as determined in 11.3.2.

NOTE 6—The plasticity index and liquid limit are determined on the minus No. 40 (425  $\mu$ m) sieve material.

11.1.1 Classify the soil as a *lean clay*, CL, if the liquid limit is less than 50. See area identified as CL on Fig. 3.

11.1.2 Classify the soil as a *fat clay*, CH, if the liquid limit is 50 or greater. See area identified as CH on Fig. 3.

NOTE 7—In cases where the liquid limit exceeds 110 or the plasticity index exceeds 60, the plasticity chart may be expanded by maintaining the same scale on both axes and extending the "A" line at the indicated slope.

11.1.3 Classify the soil as a *silty clay*, CL-ML, if the position of the plasticity index versus liquid limit plot falls on or above the "A" line and the plasticity index is in the range of 4 to 7. See area identified as CL-ML on Fig. 3.

11.2 The soil is an inorganic silt if the position of the plasticity index versus liquid limit plot, Fig. 3, falls below the "A" line or the plasticity index is less than 4, and presence of organic matter does not influence the liquid limit as determined in 11.3.2.

11.2.1 Classify the soil as a *silt*, ML, if the liquid limit is less than 50. See area identified as ML on Fig. 3.

11.2.2 Classify the soil as an *elastic silt*, MH, if the liquid limit is 50 or greater. See area identified as MH on Fig. 3.

11.3 The soil is an organic silt or clay if organic matter is present in sufficient amounts to influence the liquid limit as determined in 11.3.2.

11.3.1 If the soil has a dark color and an organic odor when moist and warm, a second liquid limit test shall be performed on a test specimen which has been oven dried at  $110 \pm 5^\circ\text{C}$  to a constant weight, typically over night.

11.3.2 The soil is an organic silt or organic clay if the liquid limit after oven drying is less than 75 % of the liquid

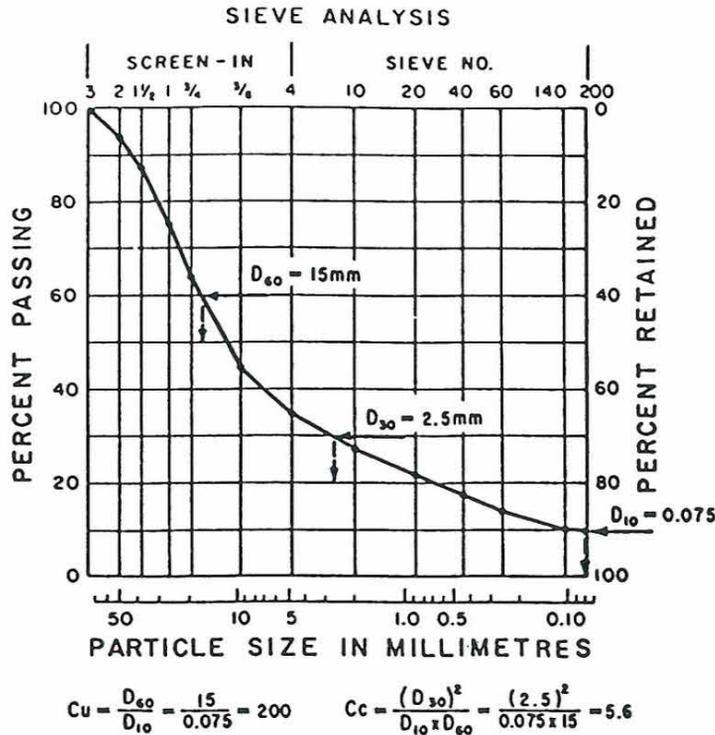


FIG. 4 Cumulative Particle-Size Plot

limit of the original specimen determined before oven drying (see Procedure B of Practice D 2217).

11.3.3 Classify the soil as an *organic silt* or *organic clay*, OL, if the liquid limit (not oven dried) is less than 50%. Classify the soil as an *organic silt*, OL, if the plasticity index is less than 4, or the position of the plasticity index versus liquid limit plot falls below the "A" line. Classify the soil as an *organic clay*, OL, if the plasticity index is 4 or greater and the position of the plasticity index versus liquid limit plot falls on or above the "A" line. See area identified as OL (or CL-ML) on Fig. 3.

11.3.4 Classify the soil as an *organic clay* or *organic silt*, OH, if the liquid limit (not oven dried) is 50 or greater. Classify the soil as an *organic silt*, OH, if the position of the plasticity index versus liquid limit plot falls below the "A" line. Classify the soil as an *organic clay*, OH, if the position of the plasticity index versus liquid-limit plot falls on or above the "A" line. See area identified as OH on Fig. 3.

11.4 If less than 30% but 15% or more of the test specimen is retained on the No. 200 (75-μm) sieve, the words "with sand" or "with gravel" (whichever is predominant) shall be added to the group name. For example, lean clay with sand, CL; silt with gravel, ML. If the percent of sand is equal to the percent of gravel, use "with sand."

11.5 If 30% or more of the test specimen is retained on the No. 200 (75-μm) sieve, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if 30% or more of the test specimen is retained on the No. 200 (75-μm) sieve and the coarse-grained portion is predominantly sand. Add the word "gravelly" if 30% or more of the test specimen is retained on the No. 200 (75-μm) sieve and the coarse-grained portion is predominantly gravel. For

example, sandy lean clay, CL; gravelly fat clay, CH; sandy silt, ML. If the percent of sand is equal to the percent of gravel, use "sandy."

12. Procedure for Classification of Coarse-Grained Soils (more than 50% retained on the No. 200 (75-μm) sieve)

12.1 Class the soil as gravel if more than 50% of the coarse fraction [plus No. 200 (75-μm) sieve] is retained on the No. 4 (4.75-mm) sieve.

12.2 Class the soil as sand if 50% or more of the coarse fraction [plus No. 200 (75-μm) sieve] passes the No. 4 (4.75-mm) sieve.

12.3 If 12% or less of the test specimen passes the No. 200 (75-μm) sieve, plot the cumulative particle-size distribution, Fig. 4, and compute the coefficient of uniformity, Cu, and coefficient of curvature, Cc, as given in Eqs 1 and 2.

$$Cu = D_{60}/D_{10} \tag{1}$$

$$Cc = (D_{30})^2/(D_{10} \times D_{60}) \tag{2}$$

where:

D<sub>10</sub>, D<sub>30</sub>, and D<sub>60</sub> = the particle-size diameters corresponding to 10, 30, and 60%, respectively, passing on the cumulative particle-size distribution curve, Fig. 4.

NOTE 8—It may be necessary to extrapolate the curve to obtain the D<sub>10</sub> diameter.

12.3.1 If less than 5% of the test specimen passes the No. 200 (75-μm) sieve, classify the soil as a *well-graded gravel*, GW, or *well-graded sand*, SW, if Cu is greater than 4.0 for gravel or greater than 6.0 for sand, and Cc is at least 1.0 but not more than 3.0.

12.3.2 If less than 5% of the test specimen passes the No. 200 (75-μm) sieve, classify the soil as *poorly graded gravel*,

GP, or *poorly graded sand*, SP, if either the Cu or the Cc criteria for well-graded soils are not satisfied.

12.4 If more than 12 % of the test specimen passes the No. 200 (75- $\mu$ m) sieve, the soil shall be considered a coarse-grained soil with fines. The fines are determined to be either clayey or silty based on the plasticity index versus liquid limit plot on Fig. 3. (See 9.8.2.1 if insufficient material available for testing). (See NOTE 6)

12.4.1 Classify the soil as a *clayey gravel*, GC, or *clayey sand*, SC, if the fines are clayey, that is, the position of the plasticity index versus liquid limit plot, Fig. 3, falls on or above the "A" line and the plasticity index is greater than 7.

12.4.2 Classify the soil as a *silty gravel*, GM, or *silty sand*, SM, if the fines are silty, that is, the position of the plasticity index versus liquid limit plot, Fig. 3, falls below the "A" line or the plasticity index is less than 4.

12.4.3 If the fines plot as a silty clay, CL-ML, classify the soil as a *silty, clayey gravel*, GC-GM, if it is a gravel or a *silty, clayey sand*, SC-SM, if it is a sand.

12.5 If 5 to 12 % of the test specimen passes the No. 200 (75- $\mu$ m) sieve, give the soil a dual classification using two group symbols.

12.5.1 The first group symbol shall correspond to that for a gravel or sand having less than 5 % fines (GW, GP, SW, SP), and the second symbol shall correspond to a gravel or sand having more than 12 % fines (GC, GM, SC, SM).

12.5.2 The group name shall correspond to the first group symbol plus "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example, well-graded gravel with clay, GW-GC; poorly graded sand with silt, SP-SM (See 9.8.2.1 if insufficient material available for testing).

NOTE 9—If the fines plot as a *silty clay*, CL-ML, the second group symbol should be either GC or SC. For example, a poorly graded sand with 10 % fines, a liquid limit of 20, and a plasticity index of 6 would be classified as a poorly graded sand with silty clay, SP-SC.

12.6 If the specimen is predominantly sand or gravel but

contains 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example, poorly graded gravel with sand, clayey sand with gravel.

12.7 If the field sample contained any cobbles or boulders or both, the words "with cobbles," or "with cobbles and boulders" shall be added to the group name. For example, silty gravel with cobbles, GM.

### 13. Report

13.1 The report should include the group name, group symbol, and the results of the laboratory tests. The particle-size distribution shall be given in terms of percent of gravel, sand, and fines. The plot of the cumulative particle-size distribution curve shall be reported if used in classifying the soil. Report appropriate descriptive information according to the procedures in Practice D 2488. A local or commercial name or geologic interpretation for the material may be added at the end of the descriptive information if identified as such. The test procedures used shall be referenced.

NOTE 10—*Example: Clayey Gravel with Sand and Cobbles (GC)*—46 % fine to coarse, hard, subrounded gravel; 30 % fine to coarse, hard, subrounded sand; 24 % clayey fines, LL = 38, PI = 19; weak reaction with HCl; original field sample had 4 % hard, subrounded cobbles; maximum dimension 150 mm.

In-Place Conditions—firm, homogeneous, dry, brown,

Geologic Interpretation—alluvial fan.

NOTE 11—Other examples of soil descriptions are given in Appendix XI.

### 14. Precision and Bias

14.1 This test method provides qualitative data only; therefore, a precision and bias statement is nonapplicable.

### 15. Keywords

15.1 Atterberg limits; classification; clay; gradation; gravel; laboratory classification; organic soils; sand; silt; soil classification; soil tests

## APPENDIXES

### (Nonmandatory Information)

#### XI. EXAMPLES OF DESCRIPTIONS USING SOIL CLASSIFICATION

XI.1 The following examples show how the information required in 13.1 can be reported. The appropriate descriptive information from Practice D 2488 is included for illustrative purposes. The additional descriptive terms that would accompany the soil classification should be based on the intended use of the classification and the individual circumstances.

XI.1.1 *Well-Graded Gravel with Sand (GW)*—73 % fine to coarse, hard, subangular gravel; 23 % fine to coarse, hard, subangular sand; 4 % fines; Cc = 2.7, Cu = 12.4.

XI.1.2 *Silty Sand with Gravel (SM)*—61 % predominantly fine sand; 23 % silty fines, LL = 33, PI = 6; 16 % fine, hard, subrounded gravel; no reaction with HCl; (field sample

smaller than recommended). *In-Place Conditions*—Firm, stratified and contains lenses of silt 1 to 2 in. thick, moist, brown to gray; in-place density = 106 lb/ft<sup>3</sup> and in-place moisture = 9 %.

XI.1.3 *Organic Clay (OL)*—100 % fines, LL (not dried) = 32, LL (oven dried) = 21, PI (not dried) = 10; wet, dark brown, organic odor, weak reaction with HCl.

XI.1.4 *Silty Sand with Organic Fines (SM)*—74 % fine to coarse, hard, subangular reddish sand; 26 % organic and silty dark-brown fines, LL (not dried) = 37, LL (oven dried) = 26, PI (not dried) = 6, wet, weak reaction with HCl.

XI.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—78 % fine to coarse, hard, subrounded to subangular gravel; 16 % fine to coarse, hard, subrounded

to subangular sand; 6 % silty (estimated) fines; moist, brown; no reaction with HCl; original field sample had 7 % hard,

subrounded cobbles and 2 % hard, subrounded boulders with a maximum dimension of 18 in.

## X2. USING SOIL CLASSIFICATION AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, ETC.

X2.1 The group names and symbols used in this test method may be used as a descriptive system applied to materials that exist in situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, etc.).

X2.2 Materials such as shells, crushed rock, slag, etc., should be identified as such. However, the procedures used in this method for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, a classification in accordance with this test method may be assigned to aid in describing the material.

X2.3 If a classification is used, the group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how soil classifications could be incorporated into a description system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. pieces of shale from power auger hole, dry, brown, no reaction with HCl. After laboratory processing by slaking in water for 24 h, material classified as “Sandy Lean Clay (CL)”—61 % clayey fines, LL = 37, PI = 16; 33 % fine to medium sand; 6 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; “Poorly Graded Sand with Silt (SP-SM)”—91 % fine to medium sand; 9 % silty (estimated) fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—62 % gravel-size broken shells; 31 % sand and sand-size shell pieces; 7 % fines; would be classified as “Poorly Graded Gravel with Sand (GP)”.

X2.4.4 *Crushed Rock*—Processed gravel and cobbles from Pit No. 7; “Poorly Graded Gravel (GP)”—89 % fine, hard, angular gravel-size particles; 11 % coarse, hard, angular sand-size particles, dry, tan; no reaction with HCl; Cc = 2.4, Cu = 0.9.

## X3. PREPARATION AND TESTING FOR CLASSIFICATION PURPOSES BY THE WET METHOD

X3.1 This appendix describes the steps in preparing a soil sample for testing for purposes of soil classification using a wet-preparation procedure.

X3.2 Samples prepared in accordance with this procedure should contain as much of their natural water content as possible and every effort should be made during obtaining, preparing, and transporting the samples to maintain the natural moisture.

X3.3 The procedures to be followed in this test method assume that the field sample contains fines, sand, gravel, and plus 3-in. (75-mm) particles and the cumulative particle-size distribution plus the liquid limit and plasticity index values are required (see 9.8). Some of the following steps may be omitted when they are not applicable to the soil being tested.

X3.4 If the soil contains plus No. 200 (75- $\mu$ m) particles that would degrade during dry sieving, use a test procedure for determining the particle-size characteristics that prevents this degradation.

X3.5 Since this classification system is limited to the portion of a sample passing the 3-in. (75-mm) sieve, the plus 3-in. (75-mm) material shall be removed prior to the determination of the particle-size characteristics and the liquid limit and plasticity index.

X3.6 The portion of the field sample finer than the 3-in. (75-mm) sieve shall be obtained as follows:

X3.6.1 Separate the field sample into two fractions on a 3-in. (75-mm) sieve, being careful to maintain the natural water content in the minus 3-in. (75-mm) fraction. Any particles adhering to the plus 3-in. (75-mm) particles shall be brushed or wiped off and placed in the fraction passing the 3-in. (75-mm) sieve.

X3.6.2 Determine the air-dry or oven-dry weight of the

fraction retained on the 3-in. (75-mm) sieve. Determine the total (wet) weight of the fraction passing the 3-in. (75-mm) sieve.

X3.6.3 Thoroughly mix the fraction passing the 3-in. (75-mm) sieve. Determine the water content, in accordance with Method D 2216, of a representative specimen with a minimum dry weight as required in 7.2. Save the water-content specimen for determination of the particle-size analysis in accordance with X3.8.

X3.6.4 Compute the dry weight of the fraction passing the 3-in. (75-mm) sieve based on the water content and total (wet) weight. Compute the total dry weight of the sample and calculate the percentage of material retained on the 3-in. (75-mm) sieve.

X3.7 Determine the liquid limit and plasticity index as follows:

X3.7.1 If the soil disaggregates readily, mix on a clean, hard surface and select a representative sample by quartering in accordance with Methods C 702.

X3.7.1.1 If the soil contains coarse-grained particles coated with and bound together by tough clayey material, take extreme care in obtaining a representative portion of the No. 40 (425- $\mu$ m) fraction. Typically, a larger portion than normal has to be selected, such as the minimum weights required in 7.2.

X3.7.1.2 To obtain a representative specimen of a basically cohesive soil, it may be advantageous to pass the soil through a 3/4-in. (19-mm) sieve or other convenient size so the material can be more easily mixed and then quartered or split to obtain the representative specimen.

X3.7.2 Process the representative specimen in accordance with Procedure B of Practice D 2217.

X3.7.3 Perform the liquid-limit test in accordance with Test Method D 4318, except the soil shall not be air dried prior to the test.

X3.7.4 Perform the plastic-limit test in accordance with Test Method D 4318, except the soil shall not be air dried prior to the test, and calculate the plasticity index.

X3.8 Determine the particle-size distribution as follows:

X3.8.1 If the water content of the fraction passing the 3-in. (75-mm) sieve was required (X3.6.3), use the water-content specimen for determining the particle-size distribution. Otherwise, select a representative specimen in accordance with Practice C 702 with a minimum dry weight as required in 7.2.

X3.8.2 If the cumulative particle-size distribution including a hydrometer analysis is required, determine the particle-size distribution in accordance with Method D 422. See 9.7 for the set of required sieves.

X3.8.3 If the cumulative particle-size distribution without a hydrometer analysis is required, determine the particle-size distribution in accordance with Method C 136. See 9.7 for the set of required sieves. The specimen should be soaked until all clayey aggregations have softened and then washed in accordance with Test Method C 117 prior to performing the particle-size distribution.

X3.8.4 If the cumulative particle-size distribution is not required, determine the percent fines, percent sand, and percent gravel in the specimen in accordance with Test Method C 117, being sure to soak the specimen long enough to soften all clayey aggregations, followed by Method C 136 using a nest of sieves which shall include a No. 4 (4.75-mm) sieve and a No. 200 (75- $\mu$ m) sieve.

X3.8.5 Calculate the percent fines, percent sand, and percent gravel in the minus 3-in. (75-mm) fraction for classification purposes.

#### X4. AIR-DRIED METHOD OF PREPARATION OF SOILS FOR TESTING FOR CLASSIFICATION PURPOSES

X4.1 This appendix describes the steps in preparing a soil sample for testing for purposes of soil classification when air-drying the soil before testing is specified or desired or when the natural moisture content is near that of an air-dried state.

X4.2 If the soil contains organic matter or mineral colloids that are irreversibly affected by air drying, the wet-preparation method as described in Appendix X3 should be used.

X4.3 Since this classification system is limited to the portion of a sample passing the 3-in. (75-mm) sieve, the plus 3-in. (75-mm) material shall be removed prior to the determination of the particle-size characteristics and the liquid limit and plasticity index.

X4.4 The portion of the field sample finer than the 3-in. (75-mm) sieve shall be obtained as follows:

X4.4.1 Air dry and weigh the field sample.

X4.4.2 Separate the field sample into two fractions on a 3-in. (75-mm) sieve.

X4.4.3 Weigh the two fractions and compute the percentage of the plus 3-in. (75-mm) material in the field sample.

X4.5 Determine the particle-size distribution and liquid limit and plasticity index as follows (see 9.8 for when these tests are required):

X4.5.1 Thoroughly mix the fraction passing the 3-in. (75-mm) sieve.

X4.5.2 If the cumulative particle-size distribution including a hydrometer analysis is required, determine the particle-size distribution in accordance with Method D 422. See 9.7 for the set of sieves that is required.

X4.5.3 If the cumulative particle-size distribution without a hydrometer analysis is required, determine the particle-size distribution in accordance with Test Method D 1140 followed by Method C 136. See 9.7 for the set of sieves that is required.

X4.5.4 If the cumulative particle-size distribution is not required, determine the percent fines, percent sand, and percent gravel in the specimen in accordance with Test Method D 1140 followed by Method C 136 using a nest of sieves which shall include a No. 4 (4.75-mm) sieve and a No. 200 (75- $\mu$ m) sieve.

X4.5.5 If required, determine the liquid limit and the plasticity index of the test specimen in accordance with Test Method D 4318.

#### X5. RATIONALE

X5.1 Significant revisions were made to the standard which appeared as D 2487 - 83 from the previous version of D 2487 - 69 (1975). The changes are documented in the literature.

X5.2 Changes in this version from the last include the

addition of 8.2 on classification of peat, the addition of 4.5 on classification of frozen soils, the addition of NOTE 6 for clarification of materials used to determine the plasticity index and liquid limit, and the addition of Appendix X5 on Rationale.

*The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.*

**F102**

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## SOIL AND ROCK SAMPLE ACQUISITION

### 1.0 PURPOSE

The purpose of this procedure is to describe the handling of rock cores and subsurface soil samples collected during drilling operations. Surface soil sampling also is described.

### 2.0 SCOPE

The methods described in this SOP are applicable for the recovery of subsurface soil and rock samples acquired by coring operations or soil sampling techniques such as split-barrel sampling and thin-walled tube sampling. Procedures for the collection of surface soil samples also are discussed. This SOP does not discuss drilling techniques or well installation procedures. ASTM procedures for "Penetration Test and Split-Barrel Sampling of Soils," "Thin-Walled Tube Sampling of Soils," and "Diamond Core Drilling for Site Investigation" have been included as Attachments A through C, respectively.

### 3.0 DEFINITIONS

Thin-Walled Tube Sampler - A thin-walled metal tube (also called Shelby tube) used to recover relatively undisturbed soil samples. These tubes are available in various sizes, ranging from 2 to 5 inches outer diameter (O.D.) and 18 to 54 inches length. A stationary piston device is included in the sampler to reduce sample disturbance and increase recovery.

Split-Barrel Sampler - A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. Also called a split-spoon sampler, this device can be driven into unconsolidated materials using a drive weight mounted on the drilling string. A standard split-spoon sampler (used for performing Standard Penetration Tests) is two inches O.D. and 1-3/8-inches inner diameter (I.D.). This standard spoon is available in two common lengths providing either 20-inch or 26-inch internal longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively.

Grab Sample - An individual sample collected from a single location at a specific time or period of time generally not exceeding 15 minutes. Grab samples are associated with surface water,

groundwater, wastewater, waste, contaminated surfaces, soil, and sediment sampling. Grab samples are typically used to characterize the media at a particular instant in time.

**Composite Samples** - A sample collected over time that typically consists of a series of discrete samples which are combined or "composited". Two types of composite samples are listed below:

- **Areal Composite**: A sample collected from individual grab samples collected on an areal or cross-sectional basis. Areal composites shall be made up of equal volumes of grab samples. Each grab sample shall be collected in an identical manner. Examples include sediment composites from quarter-point sampling of streams and soil samples from grid points.
- **Vertical Composite**: A sample collected from individual grab samples collected from a vertical cross section. Vertical composites shall be made up of equal volumes of grab samples. Each grab sample shall be collected in an identical manner. Examples include vertical profiles of soil/sediment columns, lakes and estuaries.

#### **4.0 RESPONSIBILITIES**

**Project Manager** - The Project Manager is responsible for ensuring that, where applicable, project-specific plans are in accordance with these procedures, or that other approved procedures are developed. Furthermore, the Project Manager is responsible for development of documentation of procedures which deviate from those presented herein.

**Field Team Leader** - The Field Team Leader is responsible for selecting and detailing the specific sampling techniques and equipment to be used, and documenting these in the Sampling and Analysis Plan. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

**Drilling Inspector** - It is the responsibility of the drilling inspector to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The Drilling Inspector is responsible for the proper acquisition of rock cores and subsurface soil samples.

**Sampling Personnel** - It is the responsibility of the field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper acquisition of samples.

## **5.0 PROCEDURES**

Subsurface soil and rock samples are used to characterize the three-dimensional subsurface stratigraphy. This characterization can indicate the potential for migration of contaminants from various sites. In addition, definition of the actual migration of contaminants can be obtained through chemical analysis of subsurface soil samples. Where the remedial activities may include in-situ treatment, or the excavation and removal of the contaminated soil, the depth and areal extent of contamination must be known as accurately as possible.

Surface soil samples serve to characterize the extent of surface contamination at various sites. These samples may be collected during initial site screening to determine gross contamination levels and levels of personal protection required as part of more intensive field sampling activities, to gather more detailed site data during design, or to determine the need for, or success of, cleanup actions.

Site construction activities may require that the engineering and physical properties of soil and rock be determined. Soil types, bearing strength, compressibility, permeability, plasticity, and moisture content are some of the geotechnical characteristics that may be determined by laboratory tests of soil samples. Rock quality, strength, stratigraphy, structure, etc. often are needed to design and construct deep foundations or remedial components.

### **5.1 Rock Cores**

Once rock coring has been completed and the core recovered, the rock core must be carefully removed from the barrel, placed in a core tray (previously labeled "top" and "bottom" to avoid confusion), classified, and measured for percentage of recovery, as well as the rock quality designation (RQD) (see SOP F101). If split-barrels are used, the core may be measured and classified in the split barrel after opening and then transferred to a core box.

Each core shall be described and classified on a Field Test Boring Record using a uniform system as presented in SOP F101. If moisture content will be determined or if it is desirable to prevent drying (e.g., to prevent shrinkage of hydrated formations) or oxidation of the core, the core must be wrapped in plastic sleeves immediately after logging. Each plastic sleeve shall be labeled with indelible ink. The boring number, run number and the footage represented in each sleeve shall be included, as well as the top and bottom of the core run.

After sampling, rock cores must be placed in the sequence of recovery in wooden or plastic core boxes provided by the drilling contractor. Rock cores from two different borings shall not be placed in the same core box. The core boxes should be constructed to accommodate at least 20 linear feet of core in rows of approximately five feet each and should be constructed with hinged tops secured with screws, and a latch (usually a hook and eye) to keep the top securely fastened. Wood partitions shall be placed at the end of each core run and between rows. The depth from the surface of the boring to the top and bottom of the drill run and the run number shall be marked on the wooden partitions with indelible ink. The order of placing cores shall be the same in all core boxes. The top of each core obtained should be clearly and permanently marked on each box. The width of each row must be compatible with the core diameter to prevent lateral movement of the core in the box. Similarly, any empty space in a row shall be filled with an appropriate filler material or spacers to prevent longitudinal movement of the core in the box.

The inside and outside of the core-box lid shall be marked by indelible ink to show all pertinent data pertaining to the box's contents. At a minimum, the following information must be included:

- Project name
- Date
- CTO number
- Boring number
- Footage (depths)
- Run number(s)
- Recovery
- Rock Quality Designation (RQD)
- Box number (x of x)

It is also useful to draw a large diagram of the core in the box, on the inside of the box top. This provides more room for elevations, run numbers, recoveries, comments, etc., than could be entered on the upper edges of partitions or spaces in the core box.

For easy retrieval when core boxes are stacked, the sides and ends of the box should also be labeled and include CTO number, boring number, top and bottom depths of core and box number.

Due to the weight of the core, a filled core box should always be handled by two people. Core boxes stored on site should be protected from the weather. The core boxes should be removed from the site in a careful manner as soon as possible. Exposure to extreme heat or cold should be avoided whenever possible.

## **5.2 Subsurface Soil Samples**

This section discusses three methods for collecting subsurface soil samples: (1) split-spoon sampling; (2) shelby tube sampling; and, (3) bucket auger sampling. All three methods yield samples suitable for laboratory analysis. Copies of the ASTM procedures for split-spoon sampling and shelby-tube sampling are provided in Attachments A and B, respectively.

### **5.2.1 Split-Barrel (Split-Spoon) Sampling**

The following procedures are to be used for split-spoon, geotechnical soil sampling:

1. Clean out the borehole to the desired sampling depth using equipment that will ensure that the material to be sampled is not disturbed by the operation.
2. Side-discharge bits are permissible. A bottom-discharge bit should not be used. The process of jetting through the sampler and then sampling when the desired depth is reached shall not be permitted. Where casing is used, it may not be driven below the sampling elevation.
3. The two-inch O.D. split-barrel sampler should be driven with blows from a 140-pound hammer falling 30 inches in accordance with ASTM D1586-84, Standard Penetration Test.
4. Repeat this operation at intervals not longer than 5 feet in homogeneous strata, or as specified in the Sampling and Analysis Plan.

5. Record on the Field Test Boring Record or field logbook the number of blows required to effect each six inches of penetration or fraction thereof. The first six inches is considered to be a seating drive. The sum of the number of blows required for the second and third six inches of penetration is termed the penetration resistance, N. If the sampler is driven less than 18 inches, the penetration resistance is that for the last one foot of penetration. (If less than one foot is penetrated, the logs shall state the number of blows and the fraction of one foot penetrated.) In cases where samples are driven 24 inches, the sum of second and third six-inch increments will be used to calculate the penetration resistance. (Refusal of the SPT will be noted as 50 blows over an interval equal to or less than 6 inches; the interval driven will be noted with the blow count.)
6. Bring the sampler to the surface and remove both ends and one half of the split-spoon such that the soil recovered rests in the remaining half of the barrel. Describe carefully the recovery (length), composition, structure, consistency, color, condition, etc. of the recovered soil according to SOP F101; then put into jars without ramming. Jars with samples not taken for chemical analysis should be sealed with wax, or hermetically sealed (using a teflon cap liner) to prevent evaporation of the soil moisture. Affix labels to the jar and complete Chain-of-Custody and other required sample data forms (see SOP F302). Protect samples against extreme temperature changes and breakage by placing them in appropriate cartons stored in a protected area.
7. Split-spoon samplers shall be decontaminated after each use and prior to the initial use at a site according to SOP F501.

In addition to collecting soils for geotechnical purposes, split-spoon sampling can be employed to obtain samples for environmental analytical analysis. The following procedures are to be used for split-spoon, environmental soil sampling:

1. Follow sample collection procedures 1 through 6 as outlined in Section 5.2.1.
2. After sample collection, remove the soil from the split-spoon sampler. Prior to filling laboratory containers, the soil sample should be mixed thoroughly as possible to ensure that the sample is as representative as possible of the sample interval. Soil samples for volatile organic compounds should not be mixed. Further, sample containers for volatile organic compounds analyses should be filled completely without head space remaining in the container to minimize volatilization.
3. Record all pertinent sampling information such as soil description, sample depth, sample number, sample location, and time of sample collection in the Field Test Boring Record or field logbook. In addition, label, tag, and number the sample bottle(s).
4. Pack the samples for shipping (see SOP F300). Attach seal to the shipping package. Make sure that Chain-of-Custody Forms and Sample Request Forms are properly filled out and enclosed or attached (see SOP F301).
5. Decontaminate the split-spoon sample as described in SOP F501. Replace disposable latex gloves between sample stations to prevent cross-contaminating samples.

For obtaining composite soil samples (see Definitions), a slightly modified approach is employed. Each individual discrete soil sample from the desired sample interval will be placed into a stainless-steel, decontaminated bowl prior to filling the laboratory sample containers. Special care should be taken to cover the bowl between samples with aluminum foil to minimize volatilization. Immediately after obtaining soils from the desired sampling interval, the sample to be analyzed for Volatile Organic Compounds (VOCs) should be collected. Care should be taken to obtain a representative sampling of each sample interval. The remaining soils should be thoroughly mixed. Adequate mixing can be achieved by stirring in a circular fashion and occasionally turning the soils over. Once the remaining soils have been thoroughly combined, samples for analyses other than VOCs should be placed into the appropriate sampling containers.

### 5.2.2 Thin-Wall (Shelby Tube) Sampling

When it is desired to take undisturbed samples of soil for physical laboratory testing, thin-walled seamless tube samplers (Shelby tubes) will be used. The following method applies:

1. Clean out the hole to the sampling elevation, being careful to minimize the chance for disturbance or contamination of the material to be sampled.
2. The use of bottom discharge bits or jetting through an open-tube sampler to clean out the hole shall not be allowed. Any side discharge bits are permitted.
3. The sampler must be of a stationary piston-type, to limit sample disturbance and aid in retaining the sample. Either the hydraulically operated or control rod activated-type of stationary piston sampler may be used. Prior to inserting the tube sampler in the hole, check to ensure that the sampler head contains a check valve. The check valve is necessary to keep water in the rods from pushing the sample out of the tube sampler during sample withdrawal and to maintain a suction within the tube to help retain the sample.
4. With the sampling tube resting on the bottom of the hole and the water level in the boring at the natural groundwater level or above, push the tube into the soil by a continuous and rapid motion, without impacting or twisting. In no case shall the tube be pushed further than the length provided for the soil sample. Allow a free space in the tube for cuttings and sludge.
5. After pushing the tube, the sample should sit 5 to 15 minutes prior to removal. Immediately before removal, the sample must be sheared by rotating the rods with a pipe wrench a minimum of two revolutions.

6. Upon removal of the sampler tube from the hole, measure the length of sample in the tube and also the length penetrated. Remove disturbed material in the upper end of the tube and measure the length of sample again. After removing at least an inch of soil, from the lower end and after inserting an impervious disk, seal both ends of the tube with at least a 1/2-inch thickness of wax applied in a way that will prevent the wax from entering the sample. Newspaper or other types of filler must be placed in voids at either end of the sampler prior to sealing with wax. Place plastic caps on the ends of the sampler, tape them into place and then dip the ends in wax to seal them.
7. Affix labels to the tubes and record sample number, depth, penetration, and recovery length on the label. Mark the same information and "up" direction on the tube with indelible ink, and mark the end of the sample. Complete chain-of-custody and other required forms (see SOP F302). Do not allow tubes to freeze, and store the samples vertically (with the same orientation they had in the ground, i.e., top of sample is up) in a cool place out of the sun at all times. Ship samples protected with suitable resilient packing material to reduce shock, vibration, and disturbance.
8. From soil removed from the ends of the tube, make a careful description using the methods presented in SOP F101.
9. When thin-wall tube samplers are used to collect soil for certain chemical analyses, it may be necessary to avoid using wax, newspaper, or other fillers. The SAP for each site should address specific materials allowed dependent on analytes being tested.

Thin-walled undisturbed tube samplers are restricted in their usage by the consistency of the soil to be sampled. Often very loose and/or wet samples cannot be retrieved by the samplers, and soils with a consistency in excess of very stiff cannot be penetrated by the sampler. Devices such as Dension or Pitcher cores can be used in conjunction with the tube samplers to obtain undisturbed samples of stiff soils. Using these devices normally increases sampling costs and, therefore, their use should be weighed against the increased cost and the need for an undisturbed sample. In any case, if a sample cannot be obtained with a tube sampler, an attempt should be made with a split-spoon sampler at the same depth so that at least one sample can be obtained for classification purposes.

### 5.2.3 Bucket (Hand) Auger Sampling

Hand augering is the most common manual method used to collect subsurface samples. Typically, 4-inch auger buckets with cutting heads are pushed and twisted into the ground and removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand auger is related to the material being sampled. In sands, augering is usually easily accomplished, but the depth of investigation is controlled by the depth at which sands begin to cave. At this point, auger holes usually begin

to collapse and cannot practically be advanced to lower depths, and further samples, if required, must be collected using some type of pushed or driven device. Hand augering may also become difficult in tight clays or cemented sands. At depths approaching 20 feet, torquing of hand auger extensions becomes so severe that in resistant materials, powered methods must be used if deeper samples are required.

When a vertical sampling interval has been established, one auger bucket is used to advance the auger hole to the first desired sampling depth. If the sample at this location is to be a vertical composite of all intervals, the same bucket may be used to advance the hole, as well collect subsequent samples in the same hole. However, if discrete grab samples are to be collected to characterize each depth, a new bucket must be placed on the end of the auger extension immediately prior to collecting the next sample. The top several inches of soil should be removed from the bucket to minimize the chances of cross-contamination of the sample from fall-in of material from the upper portions of the hole. The bucket auger should be decontaminated between samples as outlined in SOP F502.

In addition to hand augering, powered augers can be used to advance a boring for subsurface soil collection. However, this type of equipment is technically a sampling aid and not a sampling device, and 20 to 25 feet is the typical lower depth range for this equipment. It is used to advance a hole to the required sample depth, at which point a hand auger is usually used to collect the sample.

### 5.3 Surface Soil Samples

Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface. For loosely packed surface soils, stainless steel (organic analyses) or plastic (inorganic analyses) scoops or trowels, can be used to collect representative samples. For densely packed soils or deeper soil samples, a hand or power soil auger may be used.

The following methods are to be used:

1. Use a soil auger for deep samples (greater than 12 inches) or a scoop or trowel for surface samples. Remove debris, rocks, twigs, and vegetation before collecting the sample.

2. Immediately transfer the sample to the appropriate sample container. Attach a label and identification tag. Record all required information in the field logbook and on the sample log sheet, chain-of-custody record, and other required forms.
3. Classify and record a description of the sample, as discussed in SOP F101. Descriptions for surface soil samples should be recorded in the field logbook; descriptions for soil samples collected with power or hand augers shall be recorded on a Field Test Boring Record.
4. Store the sampling utensil in a plastic bag until decontamination or disposal. Use a new or freshly-decontaminated sampling utensil for each sample taken.
5. Pack and ship as described in SOP F300.
6. Mark the location with a numbered stake if possible and locate sample points on a sketch of the site or on a sketch in the field logbook.
7. When a representative composited sample is to be prepared (e.g., samples taken from a gridded area or from several different depths), it is best to composite individual samples in the laboratory where they can be more precisely composited on a weight or volume basis. If this is not possible, the individual samples (all of equal volume, i.e., the sample bottles should be full) should be placed in a stainless steel bucket, mixed thoroughly using a stainless steel spatula or trowel, and a composite sample collected. In some cases, as delineated in project-specific sampling and analysis plans, laboratory compositing of the samples may be more appropriate than field compositing. Samples to be analyzed for parameters sensitive to volatilization should be composited and placed into the appropriate sample bottles immediately upon collection.

## 6.0 QUALITY ASSURANCE RECORDS

Where applicable, Field Test Boring Records and Test Boring Records will serve as the quality assurance records for subsurface soil samples, rock cores and near surface soil samples collected with a hand or power auger. Observations shall be recorded in the Field Logbook as described in SOP F303. Chain-of-Custody records shall be completed for samples collected for laboratory analysis as described in SOP F302.

## 7.0 REFERENCES

1. American Society for Testing and Materials, 1987. Standard Method for Penetration Test and Split-Barrel Sampling of Soils. ASTM Method D1586-84, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.

2. American Society for Testing and Materials, 1987. Standard Practice for Thin-Walled Tube Sampling of Soils. Method D1587-83, Annual Book of Standards, ASTM, Philadelphia, Pennsylvania.
3. American Society for Testing and Materials, 1987. Standard Practice for Diamond Core Drilling for Site Investigation. Method D2113-83 (1987), Annual Book of Standards ASTM, Philadelphia, Pennsylvania.
4. U. S. EPA, 1991. Standard Operating Procedures and Quality Assurance Manual. Environmental Compliance Branch, U. S. EPA, Environmental Services Division, Athens, Georgia.

**ATTACHMENT A**

**ASTM D1586-84**

**STANDARD METHOD FOR PENETRATION TEST AND  
SPLIT-BARREL SAMPLING OF SOILS**



## Standard Method for Penetration Test and Split-Barrel Sampling of Soils<sup>1</sup>

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.*

### 1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For a specific precautionary statement, see 5.4.1.*

1.3 The values stated in inch-pound units are to be regarded as the standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

D 2487 Test Method for Classification of Soils for Engineering Purposes<sup>2</sup>

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)<sup>2</sup>

D 4220 Practices for Preserving and Transporting Soil Samples<sup>2</sup>

### 3. Descriptions of Terms Specific to This Standard

3.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 *hammer*—that portion of the drive-weight assembly consisting of the  $140 \pm 2$  lb ( $63.5 \pm 1$  kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N-value*, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9  $\Delta N$ —the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by  $360^\circ$  (see Fig. 1).

3.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

### 4. Significance and Use

4.1 This method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or *N-value*, and the engineering behavior of earthworks and foundations are available.

### 5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in

<sup>1</sup> This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 - 58 T. Last previous edition D 1586 - 67 (1974).

<sup>2</sup> Annual Book of ASTM Standards, Vol 04.08.

**ATTACHMENT B**

**ASTM D1587-83**

**STANDARD PRACTICE FOR THIN-WALLED TUBE SAMPLING OF SOILS**



## Standard Practice for Thin-Walled Tube Sampling of Soils<sup>1</sup>

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This practice has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.*

### 1. Scope

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of structural properties. Thin-walled tubes used in piston, plug, or rotary-type samplers, such as the Denison or Pitcher, must comply with the portions of this practice which describe the thin-walled tubes (5.3).

NOTE 1—This practice does not apply to liners used within the above samplers.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)<sup>2</sup>
- D 3550 Practice for Ring-Lined Barrel Sampling of Soils<sup>2</sup>
- D 4220 Practices for Preserving and Transporting Soil Samples<sup>2</sup>

### 3. Summary of Practice

3.1 A relatively undisturbed sample is obtained by pressing a thin-walled metal tube into the in-situ soil, removing the soil-filled tube, and sealing the ends to prevent the soil from being disturbed or losing moisture.

### 4. Significance and Use

4.1 This practice, or Practice D 3550, is used when it is necessary to obtain a relatively undisturbed specimen suitable for laboratory tests of structural properties or other tests that might be influenced by soil disturbance.

### 5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment may be used that provides a reasonably clean hole; that does not disturb the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

5.2 *Sampler Insertion Equipment*, shall be adequate to provide a relatively rapid continuous penetration force. For

hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

5.3 *Thin-Walled Tubes*, should be manufactured as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. and be made of metal having adequate strength for use in the soil and formation intended. Tubes shall be clean and free of all surface irregularities including projecting weld seams.

5.3.1 *Length of Tubes*—See Table 1 and 6.4.

5.3.2 *Tolerances*, shall be within the limits shown in Table 2.

5.3.3 *Inside Clearance Ratio*, should be 1 % or as specified by the engineer or geologist for the soil and formation to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled. See Fig. 1 for definition of inside clearance ratio.

5.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating. Tubes which will contain samples for more than 72 h shall be coated. The type of coating to be used may vary depending upon the material to be sampled. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, and others. Type of coating must be specified by the engineer or geologist if storage will exceed 72 h. Plating of the tubes or alternate base metals may be specified by the engineer or geologist.

5.4 *Sampler Head*, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a suitable check valve and a venting area to the outside equal to or greater than the area through the check valve. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

### 6. Procedure

6.1 Clean out the borehole to sampling elevation using whatever method is preferred that will ensure the material to be sampled is not disturbed. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the sampling operation.

6.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted. Remove loose material from the center of a casing or hollow stem auger as carefully as

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 04.08.

**ATTACHMENT C**

**ASTM D2113-83 (1987)**

**STANDARD PRACTICE FOR DIAMOND CORE DRILLING FOR  
SITE INVESTIGATION**



## Standard Practice for Diamond Core Drilling for Site Investigation<sup>1</sup>

This standard is issued under the fixed designation D 2113; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This practice describes equipment and procedures for diamond core drilling to secure core samples of rock and some soils that are too hard to sample by soil-sampling methods. This method is described in the context of obtaining data for foundation design and geotechnical engineering purposes rather than for mineral and mining exploration.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils<sup>2</sup>

D 1587 Practice for Thin-Walled Tube Sampling of Soils<sup>2</sup>

D 3550 Practice for Ring-Lined Barrel Sampling of Soils<sup>2</sup>

### 3. Significance and Use

3.1 This practice is used to obtain core specimens of superior quality that reflect the in-situ conditions of the material and structure and which are suitable for standard physical-properties tests and structural-integrity determination.

### 4. Apparatus

4.1 *Drilling Machine*, capable of providing rotation, feed, and retraction by hydraulic or mechanical means to the drill rods.

4.2 *Fluid Pump or Air Compressor*, capable of delivering sufficient volume and pressure for the diameter and depth of hole to be drilled.

4.3 *Core barrels*, as required:

4.3.1 *Single Tube Type, WG Design*, consisting of a hollow steel tube, with a head at one end threaded for drill rod, and a threaded connection for a reaming shell and core bit at the other end. A core lifter, or retainer located within the core bit is normal, but may be omitted at the discretion of the geologist or engineer.

4.3.2 *Double Tube, Swivel-Type, WG Design*—An assembly of two concentric steel tubes joined and supported at the upper end by means of a ball or roller-bearing swivel arranged to permit rotation of the outer tube without causing rotation of the inner tube. The upper end of the outer tube, or removable head, is threaded for drill rod. A threaded connection is provided on the lower end of the outer tube for

a reaming shell and core bit. A core lifter located within the core bit is normal but may be omitted at the discretion of the geologist or engineer.

4.3.3 *Double-Tube, Swivel-Type, WT Design*, is essentially the same as the double tube, swivel-type, WG design, except that the WT design has thinner tube walls, a reduced annular area between the tubes, and takes a larger core from the same diameter bore hole. The core lifter is located within the core bit.

4.3.4 *Double Tube, Swivel Type, WM Design*, is similar to the double tube, swivel-type, WG design, except that the inner tube is threaded at its lower end to receive a core lifter case that effectively extends the inner tube well into the core bit, thus minimizing exposure of the core to the drilling fluid. A core lifter is contained within the core lifter case on the inner tube.

4.3.5 *Double Tube Swivel-Type, Large-Diameter Design*, is similar to the double tube, swivel-type, WM design, with the addition of a ball valve, to control fluid flow, in all three available sizes and the addition of a sludge barrel, to catch heavy cuttings, on the two larger sizes. The large-diameter design double tube, swivel-type, core barrels are available in three core per hole sizes as follows: 2 3/4 in. (69.85 mm) by 3 1/2 in. (98.43 mm), 4 in. (101.6 mm) by 5 1/2 in. (139.7 mm), and 6 in. (152.4 mm) by 7 3/4 in. (196.85 mm). Their use is generally reserved for very detailed investigative work or where other methods do not yield adequate recovery.

4.3.6 *Double Tube, Swivel-Type, Retrievable Inner-Tube Method*, in which the core-laden inner-tube assembly is retrieved to the surface and an empty inner-tube assembly returned to the face of the borehole through the matching large-bore drill rods without need for withdrawal and replacement of the drill rods in the borehole. The inner-tube assembly consists of an inner tube with removable core lifter case and core lifter at one end and a removable inner-tube head, swivel bearing, suspension adjustment, and latching device with release mechanism on the opposite end. The inner-tube latching device locks into a complementary recess in the wall of the outer tube such that the outer tube may be rotated without causing rotation of the inner tube and such that the latch may be actuated and the inner-tube assembly transported by appropriate surface control. The outer tube is threaded for the matching, large-bore drill rod and internally configured to receive the inner-tube latching device at one end and threaded for a reaming shell and bit, or bit only, at the other end.

4.4 *Longitudinally Split Inner Tubes*—As opposed to conventional cylindrical inner tubes, allow inspection of, and access to, the core by simply removing one of the two halves. They are not standardized but are available for most core barrels including many of the retrievable inner-tube types.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 04.08.

4.5 *Core Bits*—Core bits shall be surface set with diamonds, impregnated with small diamond particles, inserted with tungsten carbide slugs, or strips, hard-faced with various hard surfacing materials or furnished in saw-tooth form, all as appropriate to the formation being cored and with concurrence of the geologist or engineer. Bit matrix material, crown shape, water-way type, location and number of water ways, diamond size and carat weight, and bit facing materials shall be for general purpose use unless otherwise approved by the geologist or engineer. Nominal size of some bits is shown in Table 1.

NOTE 1—Size designation (letter symbols) used throughout the text and in Tables 1, 2, and 3 are those standardized by the Diamond Core Drill Manufacturers' Assoc. (DCDMA). Inch dimensions in the tables have been rounded to the nearest hundredth of an inch.

4.6 *Reaming Shells*, shall be surface set with diamonds, impregnated with small diamond particles, inserted with tungsten carbide strips or slugs, hard faced with various types of hard surfacing materials, or furnished blank, all as appropriate to the formation being cored.

4.7 *Core Lifters*—Core lifters of the split-ring type, either plain or hard-faced, shall be furnished and maintained, along with core-lifter cases or inner-tube extensions or inner-tube shoes, in good condition. Basket or finger-type lifters, together with any necessary adapters, shall be on the job and available for use with each core barrel if so directed by the geologist or engineer.

4.8 *Casings:*

4.8.1 *Drive Pipe or Drive Casing*, shall be standard weight (schedule 40), extra-heavy (schedule 80), double extra-heavy (schedule 160) pipe or W-design flush-joint casing as re-

quired by the nature of the overburden or the placement method. Drive pipe or W-design casing shall be of sufficient diameter to pass the largest core barrel to be used, and it shall be driven to bed rock or to firm seating at an elevation below water-sensitive formation. A hardened drive shoe is to be used as a cutting edge and thread protection device on the bottom of the drive pipe or casing. The drive shoe inside diameter shall be large enough to pass the tools intended for use, and the shoe and pipe or casing shall be free from burrs or obstructions.

4.8.2 *Casing*—When necessary to case through formations already penetrated by the borehole or when no drive casing has been set, auxiliary casing shall be provided to fit inside the borehole to allow use of the next smaller core barrel. Standard sizes of telescoping casing are shown in Table 2. Casing bits have an obstruction in their interior and will not pass the next smaller casing size. Use a casing shoe if additional telescoping is anticipated.

4.8.3 *Casing Liner*—Plastic pipe or sheet-metal pipe may be used to line an existing large-diameter casing. Liners, so used, should not be driven, and care should be taken to maintain true alignment throughout the length of the liner.

4.8.4 *Hollow Stem Auger*—Hollow stem auger may be used as casing for coring.

4.9 *Drill Rods:*

4.9.1 *Drill Rods of Tubular Steel Construction* are normally used to transmit feed, rotation, and retraction forces from the drilling machine to the core barrel. Drill-rod sizes that are presently standardized are shown in Table 3.

4.9.2 Large bore drill rods used with retrievable inner-tube core barrels are not standardized. Drill rods used with retrievable inner-tube core barrels should be those manufactured by the core-barrel manufacturer specifically for the core barrel.

4.9.3 *Composite Drill Rods* are specifically constructed from two or more materials intended to provide specific properties such as light weight or electrical nonconductivity.

4.9.4 *Nonmagnetic Drill Rods* are manufactured of nonferrous materials such as aluminum or brass and are used primarily for hole survey work. Some nonmagnetic rods have left-hand threads in order to further their value in survey work. No standard exists for nonmagnetic rods.

4.10 *Auxiliary Equipment*, shall be furnished as required by the work and shall include: roller rock bits, drag bits, chopping bits, boulder busters, fishtail bits, pipe wrenches, core barrel wrenches, lubrication equipment, core boxes, and marking devices. Other recommended equipment includes:

TABLE 1 Core Bit Sizes

Size Designation	Outside Diameter		Inside Diameter	
	in.	mm	in.	mm
RWT	1.16	29.5	0.375	18.7
EWT	1.47	37.3	0.905	22.9
EWG, EWM	1.47	37.3	0.845	21.4
AWT	1.88	47.6	1.281	32.5
AWG, AWM	1.88	47.6	1.185	30.0
BWT	2.35	59.5	1.750	44.5
BWG, BWM	2.35	59.5	1.655	42.0
NWT	2.97	75.3	2.313	58.7
NWG, NWM	2.97	75.3	2.155	54.7
2 3/4 x 3 1/8	3.84	97.5	2.69	68.3
HWT	3.89	98.8	3.187	80.9
HWG, ...	3.89	98.8	3.000	76.2
4 x 5 1/2	5.44	138.0	3.97	100.8
6 x 7 3/4	7.66	194.4	5.97	151.6

TABLE 2 Casing Sizes

Size Designation	Outside Diameter		Inside Diameter		Threads per in.	Will Fit Hole Drilled with Core Bit Size
	in.	mm	in.	mm		
RW	1.144	36.5	1.19	30.1	5	EWT, EWG, EWM
EW	1.81	46.0	1.50	38.1	4	AWT, AWG, AWM
AW	2.25	57.1	1.91	48.4	4	BWT, BWG, BWM
BW	2.88	73.0	2.38	60.3	4	NWT, NWG, NWM
NW	3.50	88.9	3.00	76.2	4	HWT, HWG
HW	4.50	114.3	4.00	101.6	4	4 x 5 1/2
PW	5.50	139.7	5.00	127.0	3	6 x 7 1/4
SW	6.63	168.2	6.00	152.4	3	6 x 7 3/4
LW	7.63	193.6	7.00	177.8	2	...
ZW	8.63	219.0	8.00	203.2	2	...

TABLE 3 Drill Rods

Size Designation	Rod and Coupling Outside Diameter		Rod Inside Diameter		Coupling Bore, Threads		
	in.	mm	in.	mm	in.	mm	per in.
RW	1.09	27.7	0.72	18.2	0.41	10.3	4
EW	1.38	34.9	1.00	25.4	0.44	11.1	3
AW	1.72	43.6*	1.34	34.1	0.63	16.8	3
BW	2.13	53.9	1.75	44.4	0.75	19.0	3
NW	2.63	66.6	2.25	57.1	1.38	34.9	3
HW	3.50	88.9	3.06	77.7	2.38	60.3	3

core splitter, rod wicking, pump-out tools or extruders, and hand sieve or strainer.

### 5. Transportation and Storage of Core Containers

5.1 *Core Boxes*, shall be constructed of wood or other durable material for the protection and storage of cores while enroute from the drill site to the laboratory or other processing point. All core boxes shall be provided with longitudinal separators and recovered cores shall be laid out as a book would read, from left to right and top to bottom, within the longitudinal separators. Spacer blocks or plugs shall be marked and inserted into the core column within the separators to indicate the beginning of each coring run. The beginning point of storage in each core box is the upper left-hand corner. The upper left-hand corner of a hinged core box is the left corner when the hinge is on the far side of the box and the box is right-side up. All hinged core boxes must be permanently marked on the outside to indicate the top and the bottom. All other core boxes must be permanently marked on the outside to indicate the top and the bottom and additionally, must be permanently marked internally to indicate the upper-left corner of the bottom with the letters UL or a splotch of red paint not less than 1 in.<sup>2</sup> Lid or cover fitting(s) for core boxes must be of such quality as to ensure against mix up of the core in the event of impact or upsetting of the core box during transportation.

5.2 Transportation of cores from the drill site to the laboratory or other processing point shall be in durable core boxes so padded or suspended as to be isolated from shock or impact transmitted to the transporter by rough terrain or careless operation.

5.3 Storage of cores, after initial testing or inspection at the laboratory or other processing point, may be in cardboard or similar less costly boxes provided all layout and marking requirements as specified in 5.1 are followed. Additional spacer blocks or plugs shall be added if necessary at time of storage to explain missing core. Cores shall be stored for a period of time specified by the engineer but should not normally be discarded prior to completion of the project for which they were taken.

### 6. Procedure

6.1 Use core-drilling procedures when formations are encountered that are too hard to be sampled by soil-sampling methods. A 1-in. (25.4-mm) or less penetration for 50 blows in accordance with Method D 1586 or other criteria established by the geologist or engineer, shall indicate that soil-sampling methods are not applicable.

6.1.1 Seat the casing on bedrock or in a firm formation to event raveling of the borehole and to prevent loss of

drilling fluid. Level the surface of the rock or hard formation at the bottom of the casing when necessary, using the appropriate bits. Casing may be omitted if the borehole will stand open without the casing.

6.1.2 Begin the core drilling using an N-size double-tube swivel-type core barrel or other size or type approved by the engineer. Continue core drilling until core blockage occurs or until the net length of the core barrel has been drilled in. Remove the core barrel from the hole and disassemble it as necessary to remove the core. Reassemble the core barrel and return it to the hole. Resume coring.

6.1.3 Place the recovered core in the core box with the upper (surface) end of the core at the upper-left corner of the core box as described in 5.1. Continue boxing core with appropriate markings, spacers, and blocks as described in 5.1. Wrap soft or friable cores or those which change materially upon drying in plastic film or seal in wax, or both, when such treatment is required by the engineer. Use spacer blocks or slugs properly marked to indicate any noticeable gap in recovered core which might indicate a change or void in the formation. Fit fracture, bedded, or jointed pieces of core together as they naturally occurred.

6.1.4 Stop the core drilling when soft materials are encountered that produce less than 50 % recovery. If necessary, secure samples of soft materials in accordance with the procedures described in Method D 1586, Practice D 1587, or Practice D 3550, or by any other method acceptable to the geologist or engineer. Resume diamond core drilling when refusal materials as described in 6.1 are again encountered.

6.2 Subsurface structure, including the dip of strata, the occurrence of seams, fissures, cavities, and broken areas are among the most important items to be detected and described. Take special care to obtain and record information about these features. If conditions prevent the continued advance of the core drilling, the hole should be cemented and redrilled, or reamed and cased, or cased and advanced with the next smaller-size core barrel, as required by the geologist or engineer.

6.3 Drilling mud or grouting techniques must be approved by the geologist or engineer prior to their use in the borehole.

#### 6.4 Compatibility of Equipment:

6.4.1 Whenever possible, core barrels and drill rods should be selected from the same letter-size designation to ensure maximum efficiency. See Tables 1 and 3.

6.4.2 Never use a combination of pump, drill rod, and core barrel that yields a clear-water up-hole velocity of less than 120 ft/min.

6.4.3 Never use a combination of air compressor, drill rod, and core barrel that yields a clear-air up-hole velocity of less than 3000 ft/min.

7. Boring Log

- 7.1 The boring log shall include the following:
  - 7.1.1 Project identification, boring number, location, date boring began, date boring completed, and driller's name.
  - 7.1.2 Elevation of the ground surface.
  - 7.1.3 Elevation of or depth to ground water and raising or lowering of level including the dates and the times measured.
  - 7.1.4 Elevations or depths at which drilling fluid return was lost.
  - 7.1.5 Size, type, and design of core barrel used. Size, type, and set of core bit and reaming shell used. Size, type, and length of all casing used. Description of any movements of the casing.
  - 7.1.6 Length of each core run and the length or percentage, or both, of the core recovered.
  - 7.1.7 Geologist's or engineer's description of the formation recovered in each run.
  - 7.1.8 Driller's description, if no engineer or geologist is present, of the formation recovered in each run.
  - 7.1.9 Subsurface structure description, including dip of strata and jointing, cavities, fissures, and any other observations made by the geologist or engineer that could yield information regarding the formation.

7.1.10 Depth, thickness, and apparent nature of the filling of each cavity or soft seam encountered, including opinions gained from the feel or appearance of the inside of the inner tube when core is lost. Record opinions as such.

7.1.11 Any change in the character of the drilling fluid or drilling fluid return.

7.1.12 Tidal and current information when the borehole is sufficiently close to a body of water to be affected.

7.1.13 Drilling time in minutes per foot and bit pressure in pound-force per square inch gage when applicable.

7.1.14 Notations of character of drilling, that is, soft, slow, easy, smooth, etc.

8. Precision and Bias

8.1 This practice does not produce numerical data; therefore, a precision and bias statement is not applicable.

NOTE 2—Inclusion of the following tables and use of letter symbols in the foregoing text is not intended to limit the practice to use of DCDMA tools. The table and text references are included as a convenience to the user since the vast majority of tools in use do meet DCDMA dimensional standards. Similar equipment of approximately equal size on the metric standard system is acceptable unless otherwise stipulated by the engineer or geologist.

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## **WATER LEVEL, WATER-PRODUCT LEVEL MEASUREMENTS, AND WELL DEPTH MEASUREMENTS**

### **1.0 PURPOSE**

The purpose of this procedure is to describe the method of determining groundwater levels and product levels, if present, in groundwater monitoring wells. This procedure also describes determining the depth of a well.

### **2.0 SCOPE**

The methods described in this SOP generally are applicable to the measurement of water levels, product levels, and well depths in monitoring wells and piezometers.

### **3.0 DEFINITIONS**

None.

### **4.0 RESPONSIBILITIES**

**Project Manager** - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed.

**Field Team Leader** - The Field Team Leader is responsible for ensuring that these procedures are implemented in the field, and for ensuring that personnel performing these activities have been briefed and trained to execute these procedures.

**Sampling Personnel** - It is the responsibility of the sampling personnel to follow these procedures or to follow documented, project-specific procedures as directed by the Field Team Leader and/or the Project Manager. The sampling personnel are responsible for the proper acquisition of water level, water product level, and well depth measurements.

## 5.0 PROCEDURES

Calculations on water level and water-product level measurements collected from a monitoring well give an indication of:

- The horizontal hydraulic gradient (i.e., the direction of groundwater flow and the potential rate of movement [magnitude] in the horizontal plane).
- The vertical hydraulic gradient, if well nests are used (i.e., the direction of groundwater flow and the potential rate of movement in the vertical plane).
- Product thicknesses (either floating or sinking product).

This information, when combined with other site specific information such as hydraulic conductivity or transmissivity, extent of contamination, and product density, may be used to estimate contaminant movement or source areas, etc.

Well depth is one of the factors used to determine the zone that a well monitors. Well depth also is used in the calculation of purge volumes as discussed in SOP F104, Groundwater Sample Acquisition.

The following sections briefly discuss the procedures for measuring water levels, product levels, and well depth. For all of the procedures discussed, it is assumed that the measurement will be taken from the top of the steel protective casing, and that horizontal and vertical control is available for each well through a site survey, such that measurements may be converted to elevations above Mean Sea Level (MSL) or some other consistent datum.

### 5.1 Water Level Measurement

Water levels in groundwater monitoring wells shall be measured from the top of the protective steel casing, unless otherwise specified in the project plans, using an electronic water level measuring device (water level indicator). Water levels are measured by lowering the probe into the well until the device indicates that water has been encountered, usually with either a constant buzz, or a light, or both. The location on the electric cord against the measuring point surveyes on the top of the steel casing is marked. The water level is recorded to the nearest foot (rounding down) using the graduated markings on the water level indicator cord. The water level then is measured off the cord to the nearest 0.01 foot using an engineers scale. The

measurements are combined (feet plus hundredths of a foot) to yield a measurement of the depth to water below the top of the steel casing. This measurement, when subtracted from the measuring point elevation, yields the water level elevation.

Groundwater levels shall always be measured to the nearest 0.01 foot. However, reporting of water level elevations depends on the accuracy of the vertical control (typically either 0.1 or 0.01 foot).

## **5.2 Groundwater-Product Level Measurements**

The procedure for groundwater product level measurement is nearly identical to that for water level measurements. The only differences are the use of an interface probe that detects both product and water, and the indication signal given by the measurement device. Typically, encountering product in a monitoring well is indicated by a constant sound. When water is encountered, the signal becomes an alternating on/off beeping sound. This allows for the collection of measurements for both the top of the product layer in a well and the water/product interface.

The apparent water table elevation below the product level will be determined by subtracting the "depth to water" from the measuring point elevation. The corrected water table elevation will then be calculated using the following equation:

$$WTE_c = WTE_a + (\text{Free Product Thickness} \times 0.80)$$

Where:

- WTE<sub>c</sub> = Corrected water table elevation
- WTE<sub>a</sub> = Apparent water table elevation
- 0.80 = Average value for the density of petroleum hydrocarbons. Site-specific data will be used where available.

## **5.3 Well Depth Measurements**

Well depths typically are measured using a weighted measuring tape. The tape is lowered down the well until resistance is no longer felt, indicating that the weight has touched the bottom of the well. The weight should be moved in an up and down motion a few times so that obstructions, if present, may be bypassed. The slack in the tape then is collected until the tape

is taut. The well depth measurement is read directly off of the measuring tape, at the top of the steel casing, to the nearest 0.01-foot and recorded in the field logbook.

#### **5.4 Decontamination of Measuring Devices**

Water level indicators, interface probes and weighted measuring tapes that come in contact with groundwater must be decontaminated using the following steps after use in each well:

- Rinse with potable water
- Rinse with deionized water
- Rinse with:
  - ▶ Methanol or acetone (EPA Region I)
  - ▶ Methanol or acetone (EPA Region II)
  - ▶ Methanol (EPA Region III)
  - ▶ Isopropanol (EPA Region IV)
- Rinse with deionized water

Portions of the water level indicators or other similar equipment that do not come into contact with groundwater, but may encounter incidental contact during use, need only undergo potable water and deionized water rinses.

#### **6.0 QUALITY ASSURANCE RECORDS**

The field logbook shall serve as the quality assurance record for water, product level or well depth measurements.

#### **7.0 REFERENCE**

U. S. EPA, 1991. Standard Operating Procedures and Quality Assurance Manual. Environmental Compliance Branch, U. S. EPA, Environmental Services Division, Athens, Georgia.



**PHOTOIONIZATION DETECTOR (PID)  
HNu MODEL PI 101 and DL 101**

**1.0 PURPOSE**

The purpose of this SOP is to provide general reference information for using the HNu Model PI 101 or DL 101 photoionization detector (PID), or an equivalent or similar instrument, in the field. Calibration and operation, along with field maintenance will be included in this SOP.

**2.0 SCOPE**

This procedure provides information on the field operation and general maintenance of the HNu (PID). Application of the information contained herein will ensure that this type of field monitoring equipment will be used properly. Review of the manufacturer's instruction manual is a necessity for more complete information.

These procedures refer only to monitoring for health and safety. The methods are not directly applicable to surveillance of air quality for analytical purposes.

**3.0 DEFINITIONS**

Ionization Potential - In this case, a numeric equivalent that expresses the amount of energy needed to replace an electron with a photon. This energy is further defined in terms of electron volts (eV).

PID - Photoionization Detector

ppm - parts per million: parts of vapor or gas per million parts of air by volume.

**4.0 RESPONSIBILITIES**

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other approved procedures are developed. The Project Manager is responsible for selecting qualified individuals for the monitoring activities.

**Project Health and Safety Officer (PHSO)** - The Project Health and Safety Officer is responsible for developing a site-specific Health and Safety Plan (HASP) which specifies air monitoring requirements.

**Field Team Leader** - It is the responsibility of the Field Team Leader to implement these procedures in the field, and to ensure that the Field Investigation Personnel performing air monitoring activities, have been briefed and trained to execute these procedures before the start of site operations.

**Site Health and Safety Officer (SHSO)** - The SHSO is responsible for ensuring that the specified air monitoring equipment is on site, calibrated, and used correctly by the Field Personnel. The SHSO will coordinate these activities with the Field Team Leader.

**Field Investigation Personnel** - It is the responsibility of the Field Investigation Personnel to follow these procedures or to follow documented project-specific procedures as directed by the Field Team Leader/Site Health and Safety Officer. The Field Investigation Personnel are responsible for documenting all air monitoring results in both the Field Logbook and the daily Realtime Air Monitoring Log during each field investigation.

## **5.0 PROCEDURES**

The HNu utilizes the principle of photoionization whereby contaminant molecules enter the ion chamber and electrons are displaced by ultraviolet photons producing positive ions. These displaced positive ions are in turn collected on a special electrode. As the positive ions collect on the electrode, they create an electrical current which is amplified and displayed on the meter as a concentration in parts per million (ppm).

The HNu is only effective for contaminants that have ionization potentials (IP) of less than or equal to the electron volt (eV) capacity of the lamp (i.e., methane, having an IP of 12.98 eV, will not be detected at a lamp potential of 11.7 eV). The standard lamp is 10.2 eV with optional lamps of 9.5 eV and 11.7 eV, respectively. For the PI 101 the span settings should be as follows: 1.0 for 9.5 eV lamps; 9.8 for 10.2 eV lamps; and 5.0 for 11.7 eV lamps. During calibration, these span settings will be adjusted as necessary, using the span control knob.

The following subsections will discuss HNu calibration, operation, and maintenance. These sections, however, should not be used as a substitute for the manufacturer's instruction manual.

## 5.1 Calibration

For calibration purposes, the following items will be needed:

- \*Gas cylinder containing 95 to 100 parts per million (ppm) of isobutylene, balance in air.
- A 0.30 liters per minute regulator.
- Connector tubing.
- Screwdriver set.
- Calibration Gas Humidifier (for high humidity environments).
- Photoionization Detector (PID) Calibration Form.

\*Note: Do not rely on accuracy of rated concentration when cylinder content drops to <200 psi.

Prior to each use, make sure that the battery is fully charged, the ultraviolet lamp is working, and that the fan is operating and drawing air into the probe (fan operates at approximately 100 cc/minute). Procedures for completing these preliminary activities are given in the manufacturer's instruction manual.

### PI 101

To calibrate the HNu PI 101, the steps provided below should be followed. For an itemized description of the calibration process, refer to Section 3-5 in the manufacturer's instruction manual.

- Turn the function control switch to the standby position and zero the instrument by turning the zero adjustment knob to align the indicator needle with zero on the readout meter.
- Set the range on the HNu and allow the instrument to warm up a few minutes before calibrating. Choices for range are 0-20, 0-200, and 0-2,000 ppm, respectively. Range choice must take into account the concentration of the calibration gas. If you have to zero the instrument in the desired range, record background if present.
- Calibrate the HNu PID to benzene equivalents using a concentration of 100 ppm isobutylene as the calibration gas. For example, if you are using the 10.2 eV probe, your range should be set on the 0-200 scale, and calibrated to 56 ppm (i.e., adjust span

so that the instrument reads 56 units with 100 ppm isobutylene connected). Using the 11.7 eV probe the PID should read 65 units with 100 ppm of isobutylene.

- Attach tubing to the regulator (use the Calibration Gas Humidifier in high humidity environments).
- Attach the free end of the tubing to the probe and turn on the calibration gas.
- If the reading on the meter is not  $\pm 5$  percent of the concentration of the calibration gas, adjust the span setting knob until the meter reads accordingly. If after adjusting the span setting knob the readout meter is still not responding, refer to the manufacturer's instruction manual. Also, when the HNu is calibrated it should respond to a minimum of 90 percent of the concentration of the calibration gas within three seconds after introduction of that gas. If proper calibration cannot be obtained, internal calibration may be required. Note, only qualified personnel should perform internal calibrations.
- Record the calibration on the "Photoionization Detector (PID) Calibration Form".

### DL 101

To calibrate the HNu DL 101, the steps provided below should be followed. For an itemized description of the calibration process, refer to Section 4.4 in the manufacturer's instruction manual.

- Press and release the POWER button on the keypad and wait for the screen to stabilize then press the CALIBRATE key until "Calibrate?" appears. At this point press the ENTER key until "Elec\_Zero? Yes" appears on the screen in which case you will press the ENTER key, again, to confirm the electronic zero.
- The display will now read "CE/ENT/EXIT Conc = \_\_\_\_\_ ppm" which requires the concentration of the calibration gas (noted on the side of the calibration gas bottle) to be entered on the keypad. The display will prompt you to "Attach gas to probe and /ENTER/" so attach tubing to probe (use the calibration gas humidifier in high humidity environments), open valve, and press ENTER key. Press ENTER again when "Press ENTER when Ready: xxx ppm" appears on screen. This will cause "Calibrating...Please Wait" to appear on screen.

Note: This calibration is effective when the instrument is in the Survey Mode, which is the default mode. For calibrations other the one described, or if proper calibration cannot be obtained, refer to the manufacturer's instruction manual.

- For calibrations using an alternate gas or span values, refer to Section 4.5 of the manufacturer's instruction manual.

- Record the calibration on the "Photoionization Detector (PID) Calibration Form" which accompanies each HNu.

## 5.2 Operation

### PI 101

**Note:** IMPORTANT - The HNu should be "zeroed" in a fresh air environment if at all possible. If there is a background concentration, it must be documented and then zeroed out.

- Prior to each use of the HNu, check that the battery is fully charged by turning the dial to BATT and making sure that it is within range. Also make sure that the ultraviolet lamp and the fan are working properly.
- Select your desired range. HNu ranges consists of a 0-20, 0-200, and 0-2,000 ppm, respectively. Consult with the Field Team Leader for more information when choosing the appropriate range, however, in most instances the range will be set initially at 0-20.
- When HNu is used intermittently, turn knob to STANDBY to help in extending the life of the UV lamp when operating in a low humidity environment. Otherwise, leave the knob set to the range desired so that the UV lamp will "burn off" any accumulated moisture.

**Note:** When using the PI 101 HNu, make sure that you do not stick the probe in water or soil during sampling. This will cause erroneous readings and will possibly damage the instrument.

### DL 101

The DL 101 is designed to default to the survey mode when initially powered up, therefore once the calibration has been completed, the instrument is ready to go. Within the survey mode several options are available, briefly these options include:

#### (1) The Site Function

The Site function assigns a number to a site that is being analyzed. Press the Site Key on the keypad to enter a specific site number, or press the gray button on the rear of the probe to increment a site number.

## (2) Logging Data

The Log function stores data in memory. To log data, press the Log key on the keypad or the Log button on the back of the probe. "Log" will appear in the upper right corner of the display when activated and disappears when not activated. To turn logging off, press either the Log key on the keypad or the red Log button on the rear of the probe.

- The DL 101 allows for the interchanging of different voltage lamps, however, refer to the manufacturer's instructions before attempting to change the lamp.
- The DL 101 also offers three other modes of operation, the Hazardous Waste Mode, the Industrial Hygiene Mode, and the Leak Detection Mode. Each of these modes increases the range of capabilities for this instrument which is covered in detail in the manufacturer's instruction manual.

**Note:** When using the DL 101 HNu, make sure that you do not stick the probe in water or soil during sampling. This will cause erroneous readings and will possibly damage the instrument.

### 5.3 Interferences and Potential Problems

A number of factors can affect the response of the PI 101 HNu and DL 101 HNu.

- High humidity can cause lamp fogging and decreased sensitivity. This can be significant when soil moisture levels are high, or when monitoring a soil gas well that is accessible to groundwater.
- High concentrations of methane can cause a downscale deflection of the meter.
- High and low temperature, electrical fields, FM radio transmission, and naturally occurring compounds, such as terpenes in wooded areas, will also affect instrument response.

### 5.4 Maintenance

The best way to keep an HNu operating properly is to keep it as clean as possible. HNu's should be decontaminated and wiped down after each use.

## **Corrective Maintenance**

- The ultraviolet lamp should be periodically cleaned using a special compound supplied by HNu Systems, Inc. for the 10.2 eV lamp, and a chlorinated solvent such as 1,1,1-trichloroethane for the 11.7eV lamp. Consult the manufacturer's instruction manual for specific cleaning instructions.
- The ionization chamber can be periodically cleaned with methyl alcohol and a swab.

**Note:** UV lamp and ion chamber cleaning is accomplished by following the procedures outlined in Section 5.2, however, this should only be performed by trained personnel.

- Documenting the HNu's observed symptoms and then referring to the manufacturer's instruction manual section on troubleshooting (Section 6.0) also can be employed. If this does not work, the Field Team Leader should be consulted for an appropriate course of action.

**Repair and Warranty Repair -** HNu's have different warranties for different parts, so documenting the problem and sending it into the manufacturer assists in expediting repair time and obtaining appropriate warranty service.

## **6.0 QUALITY ASSURANCE RECORDS**

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the Field Logbook and the daily Realtime Air Monitoring Logs that accompany the HNu.

- Identification - Site name, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc.) serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g., the HNu meter had wide range fluctuations during air monitoring activities).

## **7.0 REFERENCES**

HNu Systems, Inc. Instruction Manual. Model PI 101, 1986.

HNu Systems, Inc. Operator's Manual. Model DL 101, 1991.



## **SAMPLE PRESERVATION AND HANDLING**

### **1.0 PURPOSE**

This SOP describes the appropriate containers for samples of particular matrices, and the steps necessary to preserve those samples when shipped off site for chemical analysis.

### **2.0 SCOPE**

Some chemicals react with sample containers made of certain materials; for example, trace metals adsorb more strongly to glass than to plastic, while many organic chemicals may dissolve various types of plastic containers. It is therefore critical to select the correct container in order to maintain the integrity of the sample prior to analysis.

Many water and soil samples are unstable and may change in chemical character during shipment. Therefore, preservation of the sample may be necessary when the time interval between field collection and laboratory analysis is long enough to produce changes in either the concentration or the physical condition of the constituent(s). While complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that may occur after the sample is collected.

Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/ freezing. Their purposes are to (1) retard biological activity, (2) retard hydrolysis of chemical compounds/complexes, (3) reduce constituent volatility, and (4) reduce adsorption effects.

Sample container and preservation requirements for the CLEAN Program are referenced in NEESA 20.2-047B and are provided in Attachment A of this SOP.

### **3.0 DEFINITIONS**

HCl - Hydrochloric Acid  
H<sub>2</sub>SO<sub>4</sub> - Sulfuric Acid  
HNO<sub>3</sub> - Nitric Acid  
NaOH - Sodium Hydroxide

Normality (N) - Concentration of a solution expressed as equivalents per liter, where an equivalent is the amount of a substance containing one mole of replaceable hydrogen or its equivalent. Thus, a one molar solution of HCl, containing one mole of H, is "one-normal," while a one molar solution of H<sub>2</sub>SO<sub>4</sub> containing two moles of H, is "two-normal."

#### 4.0 RESPONSIBILITIES

**Project Manager** - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that proper preservation and handling procedures are implemented.

**Field Team Leader** - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

**Sampling Personnel** - It is the responsibility of the field sampling personnel to initiate sample preservation and handling.

#### 5.0 PROCEDURES

The following procedures discuss sample containerization and preservation techniques that are to be followed when collecting environmental samples for laboratory analysis.

##### 5.1 Sample Containers

For most samples and analytical parameters either glass or plastic containers are satisfactory. In general, if the analyte(s) to be measured is organic in nature, the container shall be made of glass. If the analyte(s) is inorganic, then the container shall be plastic. Containers shall be kept out of direct sunlight (to minimize biological or photo-oxidation/photolysis of constituents) until they reach the analytical laboratory. The sample container shall have approximately five to ten percent air space ("ullage") to allow for expansion/vaporization if the sample is heated during transport (one liter of water at 4°C expands by 15 milliliters if heated to 130°F/55°C); however, head space for volatile organic analyses shall be omitted.

The analytical laboratory shall provide sample containers that have been cleaned according to USEPA procedures. Shipping containers for samples, consisting of sturdy ice chests, are to be provided by the laboratory.

Once opened, the sample container must be used at once for storage of a particular sample. Unused, but opened, containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or missing liners (if required for the container) shall be discarded.

General sample container, preservative, and holding time requirements are listed in Attachment A.

## 5.2 Preservation Techniques

The preservation techniques to be used for various analytes are listed in Attachment A. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or added in the field using laboratory supplied preservatives. In general, aqueous samples of low concentration organics (or soil samples of low or medium concentration organics) are cooled to 4°C. Medium concentration aqueous samples and high hazard organics samples are not preserved. Low concentration aqueous samples for metals are acidified with HNO<sub>3</sub>, while medium concentration and high hazard aqueous metal samples are not preserved. Low or medium concentration soil samples for metals are cooled to 4°C, while high hazard samples are not preserved. Unless documented otherwise in the project plans, all samples shall be considered low concentration. All samples preserved with chemicals shall be clearly identified by indicating on the sample label that the sample is preserved.

## 5.3 Sample Holding Times

The elapsed time between sample collection and initiation of laboratory analyses must be within a prescribed time frame for each individual analysis to be performed. Sample holding times for routine sample collection are provided in Attachment A.

## 6.0 SAMPLE HANDLING AND TRANSPORTATION

After collection, all sample containers will be wiped clean with a damp paper towel; however sample handling should be minimized. Personnel should use extreme care to ensure that samples are not contaminated. If samples are placed in an ice chest, personnel should ensure that melted ice cannot cause sample containers to become submerged, as this may result in sample cross-contamination. Sealable plastic bags, (zipper-type bags), should be used when small sample containers (e.g., VOAs or bacterial samples) are placed in ice chests to prevent cross-contamination.

Samples may be hand delivered to the laboratory or they may be shipped by common carrier. Relevant regulations for the storage and shipping of samples are contained in 40 CFR 261.4(d). Parallel state regulations may also be relevant. Shipment of dangerous goods by air cargo is also regulated by the United Nations/International Civil Aviation Organization (UN/ICAO). The Dangerous Goods Regulations promulgated by the International Air Transport Association (IATA) meet or exceed DOT and UN/ICAO requirements and should be used for shipment of dangerous goods via air cargo. Standard procedure for shipping environmental samples are given in Attachment B.

## 7.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, Washington, D.C.

USEPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

USEPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. USEPA EMSL, Cincinnati, Ohio.

USEPA, Region IV, 1991. Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual. Athens, Georgia.

**ATTACHMENT A**

**REQUIRED CONTAINER, PRESERVATION TECHNIQUES  
AND  
HOLDING TIMES**

**ATTACHMENT A**

**REQUIRED CONTAINERS, PRESERVATIVE TECHNIQUES AND HOLDING TIMES**

Parameter	EPA Document SW-846 (3rd Ed.)				Contract Laboratory Protocol			
	Container	Preservative	Holding Time		Container	Preservative	Holding Time	
			Soil	Water			Soil	Water
Volatiles by GC/MS and GC	Water - 40 mL glass vial with Teflon-lined septa  Soil-glass with Teflon-lined septa	Cool to 4°C	14 days	14 days	Water - 40 mL glass vial with Teflon-lined septa  Soil-glass with Teflon-lined septa	Cool to 4°C	10 days	10 days
PCB/Pesticides	G, Teflon-lined lid	Cool to 4°C	Extract within 7 days, analyze 40 days	Extract within 7 days, analyze 40 days	G, Teflon-lined lid	Cool to 4°C	Extract within 10 days, analyze 40 days	Extract within 10 days, analyze 40 days
Extractable Organics	G, Teflon-lined lid	Cool to 4°C	Extract within 7 days, analyze 40 days	Extract within 7 days, analyze 40 days	G, Teflon-lined lid	Cool to 4°C	Extract within 10 days, analyze 40 days	Extract within 10 days, analyze 40 days
Metals	P, G	HNO <sub>3</sub> to pH <2	6 months	6 months	P, G	HNO <sub>3</sub> to pH <2	180 days	180 days
Mercury	P, G	HNO <sub>3</sub> to pH <2	28 days	28 days	P, G	HNO <sub>3</sub> to pH <2	26 days	26 days
Cyanide	P, G	NaOH to pH >12 Cool to 4°C Add 0.6 g ascorbic acid if residual chlorine present	14 days	14 days	P, G	NaOH to pH >12 Cool to 4°C Add 0.6 g ascorbic acid if residual chlorine present	14 days	14 days
Chromium (Hexavalent)	P, G	HNO <sub>3</sub> to pH <2	24 hrs.	24 hrs.	P, G	HNO <sub>3</sub> to pH <2	24 hrs.	24 hrs.

**ATTACHMENT B**

**SAMPLE SHIPPING PROCEDURES**

**ATTACHMENT B**  
**SAMPLE SHIPPING PROCEDURES**

**Introduction**

Samples collected during field investigations or in response to a hazardous materials incident must be classified by the project leader, prior to shipping by air, as either environmental or hazardous materials samples. The guidance for complying with U.S. DOT regulations in shipping environmental laboratory samples is given in the "National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples."

Pertinent regulations for the shipping of samples is given in 40 CFR 261.4(d). Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods. Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by the United Nations International Civil Aviation Organization (UN/ICAO), which is equivalent to IATA.

Environmental samples shall be packed prior to shipment by commercial air carrier using the following procedures:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape. Line the cooler with a large heavy duty plastic bag. This practice keeps the inside of the cooler clean and minimizes cleanup at the laboratory after samples are removed.
2. Allow sufficient headspace (ullage) in all bottles (except VOAs) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).
3. Be sure the lids on all bottles are tight (will not leak). In many regions custody seals are also applied to sample container lids. The reason for this practice is two-fold: maintain integrity of sample and keep lid on the container should the lid loosen during shipment. Check with the appropriate regional procedures prior to field work. In many cases, the laboratory manager of the analytical lot to be used on a particular project can also provide this information.
4. It is good practice to wrap all glass containers in bubblewrap prior to placing in plastic bags.

5. Place all bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape, unless the bag is a zipper-type bag). Up to three VOA bottles, separately wrapped in bubblewrap, may be packed in one plastic bag.
6. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite.
7. Place two to four inches of vermiculite (ground corn cob, or other inert packing material) in the bottom of the cooler and then place the bottles and cans in the cooler with sufficient space to allow for the addition of more vermiculite between the bottles and cans.
8. Put frozen "blue ice" (or ice that has been placed in properly sealed, double-bagged, heavy duty polyethylene bags) on top of and between the samples. Fill all remaining space between the bottles or cans with packing material. Fold and securely fasten the top of the large garbage bag with tape (preferably electrical or duct).
9. Place the Chain-of-Custody Record and the Request for Analysis Form (if applicable) into a plastic bag, tape the bag to the inner side of the cooler lid, and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler unit. Wrap the tape three to four times around each side of the cooler unit. Chain-of-custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.
10. Label according to 40 CFR 261.4(d). The shipping containers should be marked "THIS END UP," and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper and laboratory shall be placed on the outside of the container. It is good practice to secure this label with clear plastic tape to prevent removal during shipment by blurring of important information should the label become wet. The commercial carrier is not required to sign the COC record as long as the custody seals remain intact and the COC record stays in the cooler. The only other documentation required is the completed airbill, which is secured to the top of the shipping container. Please note-several coolers/shipping containers may be shipped under one airbill. However, each cooler must be labeled as "Cooler 1 of 3, Cooler 2 of 3, etc.", prior to shipping. Additionally it is good practice to label each COC form to correspond to each cooler (i.e., 1 of 3, 2 of 3, etc.).



## CHAIN-OF-CUSTODY

### 1.0 PURPOSE

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

### 2.0 SCOPE

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters, SOP F101). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region-specific or site-specific requirements for chain-of-custody.

### 3.0 DEFINITIONS

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

#### **4.0 RESPONSIBILITIES**

**Project Manager** - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

**Field Team Leader** - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

**Sampling Personnel** - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

#### **5.0 PROCEDURES**

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

## **5.1 Sample Identification**

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s);
- CTO Number;
- Project Sample Number;
- Sample location or sampling station number;
- Date and time of sample collection and/or measurement;
- Field observations;
- Equipment used to collect samples and measurements; and,
- Calibration data for equipment used.

Measurements and observations shall be recorded using waterproof ink.

### **5.1.1 Sample Label**

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - Contract Task Order (CTO) Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 12/21/85).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 am., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.

- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

## **5.2 Chain-of-Custody Procedures**

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

### **5.2.1 Field Custody Procedures**

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographs will be stored in the project files. It is good practice to identify sample locations in photographs by including an easily read sign with the appropriate sample/location number.
- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.

### **5.2.2 Transfer of Custody and Shipment**

Samples are accompanied by a Chain-of-Custody Record Form. A Chain-of-Custody Record Form is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below.

- Enter header information (CTO number, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).
- Sign, date, and enter the time under "Relinquished by" entry.
- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).
- If a carrier is used, enter the bill-of-lading or airbill number under "Remarks," in the bottom right corner;
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in the appropriate sample shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seal across the shipping container opening so that it would be broken if the container was to be opened.
- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the sample container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the

sample container and the custody seals are intact, commercial carriers are not required to sign off on the custody form.

If sent by common carrier or air freight, proper documentation of sample transfer must be maintained.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

## **6.0 QUALITY ASSURANCE RECORDS**

Once samples have been packaged and shipped, the COC copy and airbill receipt becomes part of the Quality Assurance Record.

## **7.0 REFERENCES**

1. USEPA. User's Guide to the Contract Laboratory Program. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

**ATTACHMENT A**

**EXAMPLE SAMPLE LABEL**

**ATTACHMENT A**

**EXAMPLE SAMPLE LABEL**

<b>Baker</b>	<b>Baker Environmental Inc. Airport Office Park, Bldg. 3 420 Rouser Road Coraopolis, PA 15108</b>
<b>Project:</b> <u>19026-SRN</u>	<b>CTO No.:</b> <u>0026</u>
<b>Sample Description:</b> <u>groundwater</u>	
<b>Date:</b> <u>09/17/92</u>	<b>Sampler:</b> <u>ABC</u>
<b>Time:</b> <u>0944</u>	
<b>Analysis:</b> <u>TAL Metals (CAP)</u> <b>Preservation:</b> <u>HNO<sub>3</sub></u>	
<b>Project Sample No.:</b> <u>CAX-GW-04</u>	

**Note:** Typically, sample labels are provided by the analytical laboratory and may be used instead of the above. However, samplers should make sure all pertinent information can be affixed to the label used.

**ATTACHMENT B**

**EXAMPLE CHAIN-OF-CUSTODY RECORD**

# CHAIN-OF-CUSTODY RECORD

Sampler: \_\_\_\_\_  
(Print)

Sheet \_\_\_\_\_ of \_\_\_\_\_

**BAKER ENVIRONMENTAL, INC.**  
Airport Office Park - Bldg No. 3  
420 Rouser Road  
Coraopolis, PA 15108  
(412) 269-6000

Project Name: \_\_\_\_\_  
S. O. Number: \_\_\_\_\_

Signature: \_\_\_\_\_

### Sample Storage and Preservation Details\*

Baker Sample I.D. No.	Sample Type	Sampled		Sample Storage and Preservation Details*											
				Cooling		HNO <sub>3</sub>		H <sub>2</sub> SO <sub>4</sub> Cooling		Other		Other			
		Date	Time	No. of Contrn.	Type/Volume Contrn.	No. of Contrn.	Type/Volume Contrn.	No. of Contrn.	Type/Volume Contrn.	No. of Contrn.	Type/Volume Contrn.	No. of Contrn.	Type/Volume Contrn.		

General Remarks: \_\_\_\_\_

\*NOTES: Record type of container used with abbreviation P (plastic) or G (glass)  
Record volume of containers in liters

Relinquished By (Sign): \_\_\_\_\_  
Date: \_\_\_\_\_ Time: \_\_\_\_\_  
Remarks: \_\_\_\_\_

Received By (Sign): \_\_\_\_\_  
Date: \_\_\_\_\_ Time: \_\_\_\_\_  
Remarks: \_\_\_\_\_

Shipment/Transportation Details: \_\_\_\_\_

Relinquished By (Sign): \_\_\_\_\_  
Date: \_\_\_\_\_ Time: \_\_\_\_\_  
Remarks: \_\_\_\_\_

Received By (Sign): \_\_\_\_\_  
Date: \_\_\_\_\_ Time: \_\_\_\_\_  
Remarks: \_\_\_\_\_

Shipment/Transportation Details: \_\_\_\_\_

Relinquished By (Sign): \_\_\_\_\_  
Date: \_\_\_\_\_ Time: \_\_\_\_\_  
Remarks: \_\_\_\_\_

Received By (Sign): \_\_\_\_\_  
Date: \_\_\_\_\_ Time: \_\_\_\_\_  
Remarks: \_\_\_\_\_

Shipment/Transportation Details: \_\_\_\_\_

Distribution:  
Original - Sent with samples to lab (return with lab results to Project Manager for filing)  
Copy - Retained by sampling personnel for filing

**ATTACHMENT C**

**EXAMPLE CUSTODY SEAL**

**ATTACHMENT C**

**EXAMPLE CUSTODY SEAL**

<b>Baker</b> _____/_____/_____ <b>Date</b> _____ <b>Signature</b> <b>CUSTODY SEAL</b>	<b>Baker</b> _____/_____/_____ <b>Date</b> _____ <b>Signature</b> <b>CUSTODY SEAL</b>
--	--



## FIELD LOGBOOK

### 1.0 PURPOSE

This SOP describes the process for maintaining a field logbook.

### 2.0 SCOPE

The field logbook is a document which records all major on-site activities conducted during a field investigation. At a minimum, the following activities/events shall be recorded in the field logbook by each member of the field crew.

- Arrival/departure of site workers and visitors
- Arrival/departure of equipment
- Sample pickup (sample numbers, carrier, time)
- Sampling activities
- Start or completion of boreholes, monitoring wells, or sampling activities
- Health and safety issues

The field logbook is initiated upon arrival at the site for the start of the first on-site activity. Entries are made every day that on-site activities take place. At least one field logbook shall be maintained per site.

The field logbook becomes part of the permanent site file. Because information contained in the field logbook may be admitted as evidence in legal proceedings, it is critical that this document is properly maintained.

### 3.0 DEFINITIONS

Field logbook - The field logbook is a bound notebook with consecutively numbered pages. Upon entry of data, the logbook requires the signature of the responsible data/information recorder.

### 4.0 RESPONSIBILITIES

The Field Team Leader is responsible for maintaining a master field logbook for the duration of on-site activities. Each member of the Sampling crew is responsible for maintaining a complete and accurate record of site activities for the duration of the project.

## 5.0 PROCEDURES

The following sections discuss some of the information which must be recorded in the field logbook. In general, a record of all events and activities, as well as other potentially important information shall be recorded by each member of the field team.

### 5.1 Cover

The inside cover or title page of each field logbook shall contain the following information:

- Contract Task Order Number
- Project name and location
- Name of Field Team Leader
- Baker's address and telephone number
- Start date
- If several logbooks are required, a sequential field logbook number

It is good practice to list important phone numbers and points of contact here.

### 5.2 Daily Entries

Daily entries into the logbook may contain a variety of information. At the beginning of each day the following information must be recorded by each team member.

- Date
- Start time
- Weather
- All field personnel present
- All visitors present
- Other pertinent information (i.e., planned activities, schedule changes, expected visitors, and equipment changes)

During the day, a summary of all site activities should be recorded in the logbook. The master logbook kept by the field team leader need not duplicate that recorded in other field logbooks, but should summarize the information in other books and, where appropriate, reference the page numbers of other logbooks where detailed information pertaining to a subject may be found.

Some specific information which must be recorded in the logbook includes:

- Equipment used, equipment numbers, calibration, field servicing
- Field measurements
- Sample numbers, media, bottle size, preservatives, collection methods, and time
- Test boring and monitoring well construction information, including boring/well number and location
- Sketches for each sample location including appropriate measurements if required.
- Photograph log
- Drum log
- Other pertinent information

All entries should be made in indelible ink; all pages numbered consecutively; and all pages must be signed or initiated and dated by the responsible field personnel completing the log. No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single line, initialed, and dated.

### **5.3 Photographs**

If photographs are permitted at a site, the record shall be maintained in the field logbook. When movies, slides or photographs are taken of any site location, they are numbered or cross-referenced to correspond to logbook entries. The name of the photographer, date, time, site location, site description, direction of view and weather conditions are entered in the logbook as the photographs are taken. Special lenses, film, or other image-enhancement techniques also must be noted in the field logbook. Once processed, photographs shall be serially numbered and labeled corresponding to the field logbook entries. Note that it may not be permitted to take photographs at all Activities; permission must be obtained from the LANTDIV EIC and the Activity responsible individual.

### **6.0 QUALITY ASSURANCE RECORDS**

Once on-site activities have been completed, the field logbook shall be considered a quality assurance record.

### **7.0 REFERENCES**

None.



## DECONTAMINATION OF DRILLING RIGS AND MONITORING WELL MATERIALS

### 1.0 PURPOSE

The purpose of this SOP is to provide a general reference regarding the proper decontamination of drilling rigs and monitoring well materials used in the performance of field investigations.

### 2.0 SCOPE

This procedure addresses drilling equipment, test pit equipment (i.e. backhoe) and monitoring well material decontamination and should be consulted during the preparation of project-specific plans. This procedure does not pertain to personnel decontamination, or to chemical sampling or field analytical equipment decontamination.

### 3.0 DEFINITIONS

Decontamination - Decontamination is the process of removing or neutralizing contaminants which may have accumulated on field equipment. This process ensures protection of personnel from penetrating substances, reduces or eliminates transfer of contaminants to clean areas, prevents mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

### 4.0 RESPONSIBILITIES

**Project Manager** - It is the responsibility of the Project Manager to ensure that project-specific plans are in accordance with these procedures. Documentation should be developed for areas where project plans deviate from these procedures.

**Field Team Leader** - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field. The Field Team Leader is responsible for ensuring the field personnel overseeing decontamination activities, and personnel conducting the activities have been briefed and trained to execute these procedures.

Drilling Inspector (Site Geologist, Rig Geologist etc.) - It is the responsibility of the drilling inspector to ensure that the drilling subcontractor follows these, or other project-specific procedures as directed by the Field Team Leader.

## **5.0 PROCEDURE**

The various drilling equipment and materials involved with test boring, test pit excavation, subsurface soil sampling, and monitoring well construction must be properly decontaminated to ensure that chemical analysis results reflect actual concentrations present at sampling locations. These procedures will minimize the potential for cross contamination between sampling locations and the transfer of contamination off site.

### **5.1 Equipment**

All drilling equipment involved in field sampling activities shall be decontaminated prior to drilling, excavation, or sampling activities. Such equipment includes drilling rigs, backhoes, augers, downhole tools, well casings, and screens. Split-spoon soil samplers and other similar soil sampling devices shall be decontaminated according to the procedures given in SOP F502.

### **5.2 Decontamination Procedures**

Prior to drilling, or leaving the site, large equipment not directly utilized for sampling will be decontaminated by steam-cleaning in a designated area. The decontamination procedure consists of steam-cleaning the equipment, using potable water as the steam source, to remove visible signs of soils or wastes, and allowing the equipment to air dry. If necessary, the equipment may be cleaned with a scrub brush andalconox/liquinox-water solution prior to steam cleaning to remove visible signs of contamination.

The steam cleaning area will be designed to contain decontamination wastes and waste waters, and can be a lined, excavated pit or a bermed concrete or asphalt pad. For the latter, a floor-drain must be provided which is connected to a holding tank. A shallow, above-surface tank may be used or a pumping system with discharge to a waste tank may be installed.

At certain sites, due to the type of contaminants or proximity to residences, concerns may exist about air emissions from steam cleaning operations. These concerns can be alleviated by utilizing one or more of the following practices:

- Locate the steam cleaning area on site to minimize potential impacts.
- Enclose steam cleaning operations. For example, augers and drilling rods can be steam cleaned in drums. Tarpaulins also can be placed around the steam cleaning area to control emissions.

For a given project, the location of the steam cleaning area will be identified in the Sampling and Analysis Plan.

Decontamination wastes will be collected and contained unless otherwise directed by LANTDIV. The eventual disposition of these wastes will be determined on a project-specific basis, but may include on-site treatment and/or transport off site to an approved treatment/disposal facility.

## **6.0 QUALITY ASSURANCE RECORDS**

Rinsate samples may be collected from steam-cleaned equipment as quality assurance records. The frequency of rinsate samples from either drilling tools or well casings/screens shall be specified in the Sampling and Analysis and Quality Assurance Project Plans for a given project, as appropriate. Documentation in the field logbook also shall serve as a quality assurance record of decontamination activities.

## **7.0 REFERENCES**

None.



## DECONTAMINATION OF CHEMICAL SAMPLING AND FIELD ANALYTICAL EQUIPMENT

### 1.0 PURPOSE

The purpose of this SOP is to provide a general methodology and protocol, and to reference information for the proper decontamination of field chemical sampling and analytical equipment.

### 2.0 SCOPE

This procedure applies to all field sampling equipment including, but not limited to, split-barrel soil samplers (split-spoons), bailers, beakers, trowels, filtering apparatus, and pumps. This procedure should be consulted when decontamination procedures are being developed as part of project-specific plans. Additionally, current USEPA regional procedures and decontamination guidance as well as state guidance should be reviewed.

### 3.0 DEFINITIONS

Decontamination - Decontamination is the process of removing or neutralizing contaminants which may have accumulated on field equipment. This process ensures protection of personnel from penetrating substances, reduces or eliminates transfer of contaminants to clean areas, prevents mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

### 4.0 RESPONSIBILITIES

**Project Manager** - It is the responsibility of the Project Manager to ensure that project-specific plans are in accordance with these procedures. Documentation should be developed for areas where project plans deviate from these procedures.

**Field Team Leader** - It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field. The Field Team Leader is responsible for ensuring field personnel performing decontamination activities have been briefed and trained to execute these procedures.

**Sampling Personnel** - It is the responsibility of field sampling personnel to follow these procedures, or to follow documented, project-specific procedures as directed by the Field Team Leader.

## **5.0 PROCEDURES**

In order to ensure that chemical analysis results reflect actual concentrations present at sampling locations, sampling equipment must be properly decontaminated prior to the field effort, during the sampling program (i.e., between sampling locations) and at the conclusion of the sampling program. This will minimize the potential for cross-contamination between sampling locations and the transfer of contamination off site.

Preferably, sampling equipment should be dedicated to a given sampling location. If this is not possible, equipment must be decontaminated between sampling locations. Sampling personnel also must use disposable gloves and change them between sampling locations.

### **5.1 Sampling Equipment Decontamination Procedures**

Soil and sediment sampling equipment including, but not limited to trowels, beakers, dredges, etc., shall be decontaminated using the following USEPA Region III procedures.

The following sections summarize decontamination procedures for USEPA Regions I through IV for overall comparison. Each region should be contacted prior to initiation of sampling activities to assure that the most recent, accepted decontamination procedures are used.

#### **USEPA Region I**

Prior to use, all sampling equipment should be carefully cleaned using the following procedure:

1. A dilute hydrochloric acid rinse
2. Deionized water rinse
3. Methanol or acetone rinse; and,
4. Distilled, organic-free water rinse.

For badly contaminated equipment, a hot water detergent wash may be needed prior to the rinse procedure. Additionally, a hexane rinse also may be needed, prior to the final distilled water rinse, when sampling for low-level organic pollutants.

### USEPA Region II

Prior to use, all sampling equipment will be decontaminated using the following procedure:

1. Low-phosphate detergent wash (i.e., Alconox or Liquinox)
2. Tap water rinse
3. 10 percent nitric acid solution rinse
4. Tap water rinse
5. Methanol followed by a hexane or an acetone rinse
6. Analyte-free deionized water rinse
7. Air dry
8. Wrap in aluminum foil, shiny side out, for storage or transport

If the samples will not be analyzed for metals, then steps 3 and 4 may be omitted; if samples will not be analyzed for organics, then step 5 may be omitted. All solvents must be pesticide-grade.

### USEPA Region III

Prior to use, all sampling equipment will be decontaminated using the following procedure:

1. Potable water rinse
2. Alconox or Liquinox detergent wash
3. Scrubbing, as necessary
4. Potable water rinse
5. 10 percent nitric acid rinse
6. Distilled-deionized water rinse
7. Methanol or hexane rinse
8. Distilled-deionized water rinse
9. Air dry

### USEPA Region IV

The general decontamination procedure for Region IV is similar to that for Regions II and III. However, there may be some specialized procedures applicable to certain types of field equipment such as equipment used for the collection of samples for analysis of trace organic compounds, automatic wastewater sampling equipment, sampling tubing, and miscellaneous

equipment (i.e., pumps, hand augers, etc.). The most current version is "Standard Operating Procedures and Quality Assurance Manual," USEPA Region IV, Environmental Services Division, Environmental Compliance Branch (see Appendix B in February 1, 1991 version).

## **5.2 Field Analytical Equipment Decontamination**

Field analytical equipment which may come in direct contact with the sample or sample media, including, but not limited to water level meters, water/product level meters, pH or specific ion probes, specific conductivity probes, thermometers, and/or borehole geophysical probes must be decontaminated before and after use, according to the procedures outlined in Section 5.1, unless manufacturers instructions indicate otherwise. Probes that contact water samples not used for laboratory analyses may be rinsed with distilled water. Probes which make no direct contact (e.g. HNu or OVA probes) will be wiped clean with clean paper towels or an alcohol-saturated cloth.

## **6.0 QUALITY ASSURANCE RECORDS**

Decontamination procedures are monitored through the collection of equipment rinsate samples and field blanks. Collection of these samples shall be specified in the project-specific Sampling and Analysis and Quality Assurance Plans following the requirements of NEESA 20.2-047B. Documentation recorded in the field logbook also shall serve as a quality assurance record.

## **7.0 REFERENCES**

NEESA 20.2-047B. Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program. Naval Energy and Environmental Support Activity. Port Hueneme, CA. June 1988.

U. S. EPA Office of Waste Program Enforcement. RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD). OSWER Directive 9950.1. 1986.

U. S. EPA. Standard Operating Procedures and Quality Assurance Manual. Environmental Compliance Branch, U. S. EPA Environmental Services Division, Athens, Georgia. 1991.

Micham, J. T., R. Bellandi, E. C. Tift, Jr. "Equipment Decontamination Procedures for Ground Water and Vadose Zone Monitoring Programs: Status and Prospects." in Ground Water Monitoring Review. Spring 1989.

**ATTACHMENT 5-A  
BAKER ENVIRONMENTAL, INC.  
SAFETY STANDARD OPERATING PROCEDURES**

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**ATTACHMENT 5-A**

**BAKER ENVIRONMENTAL, INC.  
(APPLICABLE) SAFETY STANDARD OPERATING PROCEDURES**

**TABLE OF CONTENTS**

- 1.0 Confined Space Entry Program\*
- 2.0 Respiratory Protection Program
- 3.0 Care and Cleaning of Personal Protective Equipment
- 4.0 Sanitation/Site Precautions
- 5.0 Heat Stress
- 6.0 Cold Stress\*
- 7.0 Safe Boat Operations\*

\*Not Applicable

## 2.0 - RESPIRATORY PROTECTION PROGRAM

### 2.1 INTRODUCTION

In accordance with OSHA requirements (29 CFR 1910.134), this document represents Baker Environmental, Inc.'s (Baker's) program governing the selection and use of respiratory protection for its employees. It is Baker's policy to provide its employees with the proper protective equipment, training, and medical surveillance necessary to protect individuals from any potential hazards which may be present during the tasks performed throughout the course of each individual's employment. This program specifically describes the procedures which have been established and implemented for the use of respiratory protection equipment. The effectiveness of this program shall be reevaluated on an annual basis and appropriate changes shall be made if deemed necessary.

### 2.2 EMPLOYER RESPONSIBILITY

Baker shall provide its employees the respiratory protection equipment which is appropriate and suitable for the purpose intended, when such equipment is necessary to protect the health of the employee.

### 2.3 EMPLOYEE RESPONSIBILITY

The employee shall use the respiratory protection provided in accordance with instructions and training received, and shall report any malfunction of the equipment to a responsible person. The employee shall not wear contact lenses in atmospheres where respiratory protection is required. Corrective lens inserts will be provided, at Baker's expense, for employees who require corrective lenses.

### 2.4 HAZARD ASSESSMENT

The key elements of a respiratory protection program must start with an assessment of the inhalation and ingestion hazards present in the work area. Because Baker's services involve a variety of environmental and industrial hygiene studies, it is not practical to identify all

possible hazards to which all employees could be exposed within the scope of this document. Therefore, it is essential that a task specific assessment be conducted prior to the initiation of any activities on a given project. This task specific assessment may be part of the site-specific Health and Safety Plan.

After a task-specific assessment is completed and it is determined that airborne exposure concentrations exceed or may exceed the recommended limits, engineering and administrative controls should be implemented, whenever feasible.

If the exposure cannot be reduced, or it is not feasible to reduce the airborne exposure below the recommended limits, respirators will be selected by the Site Health and Safety Officer on the basis of:

- Toxicity
- Maximum Expected Concentration
- Oxygen Levels
- Warning properties of the substance(s) involved
- Sorbent Limitations
- Facepiece Fit
- Mobility Requirements
- Type of Use (routine, escape, or emergency entry)
- Possibility of Ingestion of Toxic Materials
- Respirator Attributes

## 2.5 TRAINING

Each respirator wearer shall be given training, by a qualified individual, which will include explanations and discussions of:

- Opportunity to wear respiratory protection in an uncontaminated environment.
- Respirator Fit Testing (qualitative)
- The respiratory hazard(s) and what may occur if the respirator is not used properly.
- The reasons for selecting a particular type of respirator.
- The function, capabilities, and limitations of the selected respirator.
- The method of donning the respirator and checking its fit and operation.
- The proper wearing of the respirator.

- Respirator maintenance, repair, and cleaning.
- Recognizing and handling emergency situations.

Respirator training will be conducted on an annual basis, at a minimum. Records of the training and fit-testing will be maintained for a minimum of 30 years following termination of employment for each employee.

## 2.6 TYPES OF RESPIRATORS

Baker provides employees with the North Brand half-face (Model 7700) and full-face (Model 7600) air purifying respirators, positive pressure 30-minute Self-Contained Breathing Apparatus (SCBAs) (Model 800), positive pressure supplied airline respirators, with 5-minute escape air cylinders (Model 85500). Only respiratory equipment certified by the appropriate approval agencies (e.g., NIOSH, MSHA) according to Title 30, Part II of the Code of Federal Regulations, will be distributed to Baker employees. As an alternate air purifying respirator, Baker will also keep, on-hand, the MSA ultra twin full-face respirator. All Baker employees who regularly perform tasks requiring respiratory protection will be issued their own half-face or full-face respirator, provided the employee can achieve a proper fit and is medically capable of wearing the equipment.

Because 30-minute SCBAs, positive pressure supplied airline respirators, and 5-minute escape air cylinders are used less frequently, this equipment will be distributed on an as-needed basis.

## 2.7 AIR QUALITY

Compressed and liquid air used for respiration shall be of high purity. Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966. Breathing air may be supplied to respirators from cylinders or air compressors. Oxygen must never be used with air line respirators.

Air cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178). Air line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air line respirators with nonrespirable gases or oxygen.

Breathing gas containers shall be marked in accordance with American National Standard Method of marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1-1954; Federal Specification BB-A-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG-B-00675b, April 27, 1965, Breathing Apparatus, Self-Contained.

## 2.8 CLEANING AND MAINTENANCE

Respirator maintenance will be performed by each trained individual on a regular basis. The maintenance shall be carried out on a schedule which ensures that each respirator wearer is provided with a respirator that is clean and in good operating condition.

Respiratory equipment that is used on an as-needed basis shall be maintained by qualified personnel. This equipment shall be cleaned/sanitized, then rinsed and air-dried, after each use. Inspections shall be conducted before and after each use.

Respiratory equipment that has been issued to an employee shall be cleaned/sanitized then rinsed and air-dried by the wearer on a schedule (specified by OSHA in 29 CFR 1910.134) which ensures that it will be maintained in clean and good operating condition. Inspections shall be conducted on a regular basis during usage and prior to each project requiring the potential usage of the equipment.

All respirators shall be stored in a plastic bag within a cool/dry location, in a manner that will protect them against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. They shall be stored to prevent distortion of rubber or other elastomer parts.

Parts replacement and repairs shall be performed only by appropriate personnel. Equipment requiring repairs shall be reported to appropriate Baker personnel. Examples of inspection forms are included at the end of this text.

## 2.9 FIT-TESTING

Each respirator wearer shall be provided with a respirator that can properly form a secure face to mask seal. Each wearer shall be fit-tested prior to issuance of the respirator using either an irritant smoke or odorous vapor, or other suitable test agent (see example of form at end of

text). Retesting shall be performed, at a minimum, on an annual basis or if a different model respirator, other than the model he/she was previously fit-tested for, is to be used by the wearer. Air purifying respirators fit-tested qualitatively will be assigned a protection factor of 10 (APF = 10).

Facial hair, which interferes with the normally effective face to mask seal, is prohibited. Each respirator wearer shall be required to check the seal of the respirator by negative and positive pressure checks prior to entering a harmful atmosphere.

## **2.10 MEDICAL SURVEILLANCE**

Personnel who are or may be assigned to tasks requiring use of respirators shall participate in a medical surveillance program on an annual basis. The medical surveillance program shall include, but may not be limited to, a physical and a pulmonary function test conducted by the company's physician and at the expense of the company. Test parameters included in Baker's medical surveillance program is included as Attachment A in each site-specific Health and Safety Plan.

## **2.11 LIMITATIONS**

Wearing any respirator, alone or in conjunction with other types of protective equipment, will impose some physiological stress on the wearer. Therefore, selection of respiratory protective devices will be based on the breathing resistance, weight of the respirator, the type and amount of protection needed as well as the individual's tolerance of the given device. Additional concerns regarding the limitations of different types of PPE and the monitoring requirements for heat stress/strain will be addressed in the "Heat Stress" SOP.





# RESPIRATOR FIT TEST RECORD



TEST SUBJECT NAME \_\_\_\_\_  
(last) (first) (initial)

DATE \_\_\_\_\_ DEPARTMENT \_\_\_\_\_

SEX (M/F) \_\_\_\_\_ AGE \_\_\_\_\_ SOCIAL SECURITY NUMBER \_\_\_\_\_

RESPIRATOR MEDICAL DATE \_\_\_\_\_ RESPIRATOR TRAINING DATE \_\_\_\_\_

**SPECIAL/UNUSUAL CONDITIONS/CONSIDERATIONS:**

- |  |  |
|--|--|
| <input type="checkbox"/> Claustrophobia<br><input type="checkbox"/> Facial hair<br><input type="checkbox"/> Eyeglasses<br><input type="checkbox"/> Contacts<br><input type="checkbox"/> Other: _____ | <input type="checkbox"/> Scars<br><input type="checkbox"/> Broken or crooked nose<br><input type="checkbox"/> Extreme facial dimensions<br><input type="checkbox"/> Wrinkles |
|--|--|

### RESPIRATOR SELECTION

Manufacturer/Model	Size	Style	
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___
_____	S ___ M ___ L ___	Half ___ Full ___	Pass ___ Fail ___

Testing Agent	Qualitative Test	Sensitivity Check
Isoamyl Acetate	Yes: ___ No: ___	Yes: ___ No: ___
Irritant Smoke	Yes: ___ No: ___	Yes: ___ No: ___

### TEST EXERCISES (Check all that apply)

- |                          |                       |
|--------------------------|-----------------------|
| Normal Breathing _____   | Talking _____         |
| Deep Breathing _____     | Running _____         |
| Head, Side to Side _____ | Bending _____         |
| Head, Up and Down _____  | Rainbow Passage _____ |

COMMENTS: \_\_\_\_\_

Signed: \_\_\_\_\_  
 (Test Subject)

Signed: \_\_\_\_\_  
 (Technician/Instructor)



## 3.0 - CARE AND CLEANING OF PERSONAL PROTECTIVE EQUIPMENT

### 3.1 INTRODUCTION

The following procedures cover the care and cleaning of Levels D, C, and B personal protective equipment. Note: These are general procedures that apply to most situations and are not all inclusive. Procedures are subject to change at the direction of the Site Health and Safety Officer (SHSO).

### 3.2 EQUIPMENT CARE

#### 3.2.1 Chemical Resistant Suit (Levels C and B)

- Before donning, inspect suit for holes or tears; check to see that zippers are operable; and look for signs of suit degradation.
- When wearing, avoid contact with contaminated material where possible; be aware of sharp objects that can tear suit; periodically look over suit to check for major rips or tears.
- While decontaminating, remove gross excess of material from suit; remove suit so that material does not contact inner suit; place clothing in properly labeled disposal containers.

#### 3.2.2 Inner/Outer Gloves (Levels D through B)

- Look for rips, tears, or degradation of material. Replace as necessary or at the direction of the SHSO.

#### 3.2.3 Chemically Resistant Boots (Levels C and B)

- Nondisposable boots are to be examined on a daily basis before and after use. Disposable boots should be examined prior to donning and while in use. Dispose of according to site procedures.

#### **3.2.4 Safety Shoes/Boots (Levels D through B)**

- Examine daily for gauges, open seams, etc., anything that would lessen the integrity of the boot. Replace as shoe/boot becomes worn.

#### **3.2.5 Hard Hats (Levels D through B)**

- Should be visually inspected before donning for fit, cracks, and overall condition.

#### **3.2.6 Safety Glasses/Goggles (Levels D and C)**

- Should be visually inspected before donning for cracks, deteriorated parts, and overall condition. Replace as necessary.

#### **3.2.7 Respirators (Levels C and B)**

- Procedures for care of respiratory protective equipment are covered in Attachment D - Baker SOPs.

#### **3.2.8 Hearing Protection (Levels D through B)**

- Disposable - Replace daily, or as material becomes worn or dirty.
- Reusable - Inspect before use, clean regularly, replace parts as necessary.

### **3.3 EQUIPMENT CLEANING**

General procedures for cleaning of equipment are listed below. Site-specific concerns will be addressed by the SHSO prior to and during site activities. Cleaning of respiratory equipment is covered under the "Respiratory Protection Program" SOP.

#### **3.3.1 Gross Physical Removal**

Large amounts of contaminated soil is scraped off with a tongue depressor, or wiped off using a disposable wipe.

### **3.3.2 Physical/Chemical Removal**

The residual contamination will be scrubbed with a soft-bristled, long-handled brush using a nonphosphate detergent solution.

### **3.3.3 Rinsing/Dilution**

The detergent solution and residual contaminants will be rinsed with tap water using a pressurized sprayer.

## 4.0 - SANITATION/SITE PRECAUTIONS

### 4.1 SANITATION

- A supply of clearly marked potable water, tightly closed, and equipped with a tap.
- Single service disposal cups.
- Outlets for non-potable water, clearly marked, for fire fighting, or other purposes. Cross-contamination of the potable supply shall be prevented.
- One toilet facility which is either chemical, recirculating, combustion, or flush, depending on local code requirements.
- A place for food handling meeting all applicable laws, otherwise, suitable alternatives to such facilities will be provided (i.e., nearby restaurants, food wagons, etc.).
- Clean wash water will be available in the decontamination zone and the Baker Site Trailer.

### 4.2 SITE PRECAUTIONS

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material, is prohibited in any area designated as contaminated.
- Smoking will not be allowed in areas where flammable materials are present.
- Hands and face must be thoroughly washed upon leaving the work area.
- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

- No contaminated work garments are to be worn off site.
- Contact lenses are not permitted to be worn on site.
- No facial hair which interferes with a satisfactory fit of the mask-to-face seal, is allowed on personnel required to wear respirators.
- Contact with contaminated or potentially contaminated surfaces should be avoided. Wherever possible, do not walk through puddles, leachate, discolored surfaces, kneel on ground, lean, sit or place equipment on drums/containers.
- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel where the potential for absorption, inhalation, or ingestion of toxic substances exist unless specifically approved by a qualified physician. Alcoholic beverage intake should be minimized or avoided during after-hour operations.
- Alcoholic beverages are prohibited on site.
- Personal radios, TVs, and tape players are prohibited on site.
- Firearms are prohibited on site.
- All personnel will observe any posted sign, warning, fence, or barrier posted around contaminated areas.



## 5.0 - HEAT STRESS

### 5.0 HEAT STRESS

#### Monitoring

Provisions for monitoring for heat stress will be determined by the SHSO and performed as outlined below.

Heat stress monitoring is required for personnel wearing semipermeable or impermeable protective outerwear when there is an ambient air temperature greater than 70°F. One or more of the following procedures will be implemented when this condition exists:

1. Increased awareness of heat stress symptoms and buddy monitoring.
2. Fluid intake discipline.
3. Self monitoring of urine output quantities to prevent dehydration.
4. Work-rest intervals.
5. Calculate the Heat Exposure Threshold Limit Value (TLV) for work-rest intervals using the following steps:
  - a. Calculate the WBGT (Wet Bulb Globe Temperature) Index using the Quest® Heat Stress Monitor
  - b. Estimate the work load using the following guidelines:
    - (1) Light work = sitting or standing to control machines, performing light hand or arm work.
    - (2) Moderate work = walking about with moderated lifting and pushing.
    - (3) Heavy work = pick and shovel work.
  - c. Evaluate the calculations against the following Heat Exposure TLVs in °C or °F.

Work - Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous work	30.0 (86)	26.7 (80)	25.0 (77)
75% work - 25% rest, each hour	30.6 (87)	28.0 (82)	25.9 (78)
50% work - 50% rest, each hour	31.4 (89)	29.4 (85)	27.9 (82)
25% work - 75% rest, each hour	32.2 (90)	31.1 (88)	30.0 (86)

\* For unacclimatized workers, the permissible heat exposure TLV should be reduced by 2.5°C.

### Special Considerations

- Clothing - Subtract 2 from the TLV to compensate for the use of semipermeable clothing.
- Acclimatization - After approximately a week, workers should have acclimated themselves to their environment.
- Fitness - Physically fit workers will adjust more readily to a change in environment.
- Medication - Some medications can predispose individuals to heat-induced illnesses.

### Causes and Symptoms

The following heat stress causes and symptoms are provided for buddy monitoring purposes. Site personnel must realize that monitoring the physical condition of fellow personnel in Level B and C protective ensembles will be difficult.

1. *Heat rash* results from continuous exposure to heat or humid air.
2. *Heat cramps* are caused by heavy sweating and inadequate fluid intake. Symptoms include muscle spasms and pain in the hands, feet, and abdomen.
3. *Heat exhaustion* occurs when body organs attempt to keep the body cool, due to inadequate fluid intake and personnel not acclimated to the environment. Symptoms include pale, cool, moist skin; heavy sweating; and dizziness.

4. *Heat stroke* is the most serious form of heat stress. It is a MEDICAL EMERGENCY. Symptoms are red, hot, dry skin; lack of perspiration; nausea; dizziness and confusion; strong, rapid pulse rate; and coma.

The need to seek medical attention and the urgency in seeking medical attention depends on the symptoms and the severity of the symptoms displayed by the affected individual. If *heat stroke* is noted or suspected, medical attention must be sought IMMEDIATELY. Efforts should be taken to cool the body to prevent serious injury or death. Excessive cooling can cause hypothermia and should be avoided.

### Prevention

Fluid intake should be increased during rest schedules to prevent dehydration. Drinking cool water is best; however, diluted electrolyte solutions (i.e., Gatorade or equivalent) can be substituted for water. Each individual should monitor their urine output and adjust their fluid intake to ensure that urine output and urine color are close to normal. Additional means for preventing heat-induced illnesses may include providing shelter or cooling devices, such as vests and showers.

**ATTACHMENT 5-B**  
**MATERIAL SAFETY DATA SHEETS**

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# Material Safety Data Sheet

from Genium's Reference Collection  
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GENIUM PUBLISHING CORP.

No. 300

ACETONE  
(Revision E)

Issued: September 1985  
Revised: November 1988

## SECTION 1. MATERIAL IDENTIFICATION

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Material Name: ACETONE

Description (Origin/Uses): Used as a solvent for fats, oils, waxes, resins, rubber, plastics, varnishes, and rubber cements; also used in the manufacture of methyl isobutyl ketone, mesityl oxide, acetic acid, diacetone alcohol, chloroform, iodoform, bromoform, explosives, rayon, photographic films, and isoprene. Used to store acetylene gas. Widely used in the chemical process industry (CPI).

Other Designations: Dimethylformaldehyde; Dimethylketal; Dimethyl Ketone; Ketone Propane; Pyroacetic Acid; Pyroacetic Ether; C<sub>3</sub>H<sub>6</sub>O; CAS No. 0067-64-1

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.



NFPA

HMIS  
H 1 R 1  
F 3 I 1  
R 0 S 2  
PPG\*  
\*See sect. 8 K 4

## SECTION 2. INGREDIENTS AND HAZARDS

Acetone, CAS No. 0067-64-1

%  
Ca 100

### EXPOSURE LIMITS

OSHA PELs  
8-Hr TWA: 750 ppm, 1800 mg/m<sup>3</sup>  
STEL: 1000 ppm, 2400 mg/m<sup>3</sup>  
ACGIH TLVs, 1988-89  
TLV-TWA: 750 ppm, 1780 mg/m<sup>3</sup>  
TVL-STEL: 1000 ppm, 2375 mg/m<sup>3</sup>  
Toxicity Data\*  
Man, Inhalation, TD<sub>Lo</sub>: 440 µg/m<sup>3</sup> (6 Mins)  
Man, Inhalation, TD<sub>Lo</sub>: 10 mg/m<sup>3</sup> (6 Hrs)

\*See NIOSH, RTECS (AL3150000), for additional data with references to reproductive, mutagenic, and irritative effects.

## SECTION 3. PHYSICAL DATA

Boiling Point: 134°F (56°C)  
Melting Point: -137°F (-94°C)  
Vapor Density (Air = 1): 2  
Vapor Pressure: 180 Torr at 68°F (20°C)  
Evaporation Rate: Faster than That of *n*-Butyl Acetate

Molecular Weight: 58 Grams/Mole  
Solubility in Water (%): Complete  
Specific Gravity (H<sub>2</sub>O = 1): 0.778 at 77°F (25°C)  
% Volatile by Volume: 100

Appearance and Odor: A clear, colorless, highly flammable, volatile liquid with a characteristic, pleasant, sweetish odor.

## SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: 1.4°F (-17°C) CC    Autoignition Temperature: 869°F (465°C)    LEL: 2.9% v/v    UEL: 12.8% v/v

Extinguishing Media: Use "alcohol" foam, dry chemical, or carbon dioxide. Use a blanketing effect to smother flames. Use water spray to reduce the rate of burning and to cool containers. Water will probably not be effective in directly extinguishing an acetone fire.

Unusual Fire or Explosion Hazards: Acetone vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

Stability/Polymerization: Acetone is stable in closed containers during routine operations. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Acetone can react dangerously with strong oxidizing agents such as nitrates, perchlorates, permanganates, and concentrated sulfuric acid; chromic anhydride; chromyl chloride; hydrogen peroxide; hexachloromelamine; nitrosyl chloride; permonosulfuric acid; mixtures of sulfuric acid and nitric acid; mixtures of nitric acid and acetic acid; and potassium *tert*-butoxide.

Conditions to Avoid: Do not expose acetone to sources of ignition and incompatible chemicals.

Hazardous Products of Decomposition: Carbon monoxide and carbon dioxide can be produced during acetone fires.

**SECTION 6. HEALTH HAZARD INFORMATION**

**Carcinogenicity:** Acetone is not listed as a carcinogen by the NTP, IARC, or OSHA.  
**Summary of Risks:** Inhalation of high concentrations of acetone vapor can cause dryness of the mouth and throat; dizziness, nausea, incoordination, slurred speech, drowsiness, and, in severe exposures, coma. Inhalation of small quantities of acetone vapor for an extended period causes irritation of the respiratory tract, coughing, and headache. Prolonged or repeated skin contact with acetone has a defatting effect causing dryness, irritation, and mild dermatitis. Under routine operating conditions the amount of acetone absorbed through the skin is small. Ingestion of acetone may cause irritation of the gastrointestinal tract and narcosis. Acetone acts primarily as a depressant to the central nervous system (CNS) when exposures are severe or prolonged. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** See Summary of Risks, above. **Chronic Effects:** None reported. **FIRST AID:** **Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Monitor the exposed person for symptoms of depression of the CNS such as incoordination and drowsiness. **Ingestion.** Unlikely. \* If a small amount is ingested, dilute it slowly with 1 to 2 glasses of water or milk. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. \*Note to Physician: Treatment for accidental ingestion of a small amount of acetone is unnecessary. If a large amount has been ingested, administer a charcoal slurry, either aqueous or mixed with a saline cathartic or sorbital.

**SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES**

**Spill/Leak:** Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup personnel need protection against this liquid's contact with skin or eyes as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Consider saving the waste hydrochloric acid for use as a neutralizing agent during cleanup operations of basic materials.  
**OSHA Designations**  
 Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).  
**EPA Designations (40 CFR 302.4)**  
 RCRA Hazardous Waste, No. U002  
**CERCLA Hazardous Substance, Reportable Quantity:** 5000 lbs (2270 kg), per the Resource Conservation and Recovery Act, § 3001.

**SECTION 8. SPECIAL PROTECTION INFORMATION**

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious butyl or natural rubber gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** Automatic sprinkler systems for fire protection are desirable in work areas. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale acetone vapor.

**SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS**

**Storage/Segregation:** Store acetone in closed containers (carbon steel is recommended) in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks. **Other Precautions:** Use labeled safety cans when handling small amounts of acetone. Acetone presents a dangerous fire hazard; perform all work operations involving it carefully and in a way that will prevent exposing the liquid or its vapor to sources of ignition.

**Transportation Data (49 CFR 172.101-2)**  
**DOT Shipping Name:** Acetone **IMO Hazard Class:** 3.1  
**DOT Hazard Class:** Flammable Liquid **IMO Label:** Flammable Liquid  
**ID No. UN1090** **IMDG Packaging Group:** II  
**DOT Label:** Flammable Liquid

**References:** 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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**Section 1. Material Identification**

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**Coal Tar Creosote (molecular formula varies with purity) Description:** Three main derivations: by distillation of coal tar produced by high-temperature carbonization of bituminous coal; by mixing strained naphthalene oil, wash oil, and strained or light anthracene oil; as a by-product of conventional coal coking. It typically contains up to 160 chemicals, mainly aromatic compounds such as phenol, pyrol and pyridine. Used mainly as a wood preservative for railroad ties, poles, fence posts, marine pilings, and other lumber for outdoor use; as a water-proofing agent, fuel oil constituent, frothing agent for mineral separation, hop defoliant, and lubricant for die molds; in manufacturing chemicals; and in medicine as an antiseptic, disinfectant, antipyretic, astringent, germicide, and styptic.  
**Other Designations:** CAS No. 8001-58-9, Awpa, brick oil, Caswell No. 225, coal tar oil, creosote, creosote oil, creosotum, cresylic creosote, heavy oil, liquid pitch oil, naphthalene oil, Preserv-o-sote, Sakresote, tar oil, wash oil.  
**Manufacturer:** Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide* for a suppliers list.  
**Cautions:** Flammable, liquid coal tar creosote is toxic by inhalation, ingestion, and skin contact. The IARC and NTP classify it as a *human carcinogen*.

R 1  
I 4  
S 4\*  
K 2  
\* Skin absorption



NFPA  
HMIS  
H 2  
F 2  
R 0  
PPG†  
† Sec. 8

\* Skin absorption can occur with phenol, a major component of coal tar creosote.

**Section 2. Ingredients and Occupational Exposure Limits**

Coal tar creosote, ca 100%

1990 OSHA PEL  
8-hr TWA: 0.2 mg/m<sup>3</sup>\*

1990-91 ACGIH TLV  
TWA: 0.2 mg/m<sup>3</sup>\*

1985-86 Toxicity Data†

Rat, oral, LD<sub>50</sub>: 725 mg/kg; toxic effects not yet reviewed  
Dog, oral, LD<sub>50</sub>: 600 mg/kg; toxic effects not yet reviewed  
Rat, TD<sub>01</sub>: 52,416 mg/kg administered during 91 days prior to mating produces reproductive effects on fallopian tubes and ovaries  
Mouse, skin, TD<sub>01</sub>: 99 g/kg produces tumors in skin and appendages

1987 IDLH Level  
700 mg/m<sup>3</sup>

1990 NIOSH REL  
0.1 mg/m<sup>3</sup> (cyclohexane extractable portion)

\* As coal tar pitch volatiles.

† See NIOSH, *RTECS* (GF8615000), for additional mutation, reproductive, tumorigenic, and other toxicity data.

**Section 3. Physical Data**

Boiling Point: 381 to 752 °F (194 to 400 °C)  
Distillation Range: 446 to 554 °F (230 to 290 °C)  
Heat of Combustion: -12,500 Btu/lb  
Heat of Vaporization: 107 Btu/lb

Molecular Weight: Varies with purity  
Density/Specific Gravity: 1.07 to 1.08 at 68 °F (20 °C)  
Water Solubility: Slightly soluble

**Appearance and Odor:** Pure coal tar creosote is colorless, but the industrial product is a yellow to black oily liquid with an aromatic smoky smell and a burning caustic taste.

**Section 4. Fire and Explosion Data**

Flash Point: 165.2 °F (74 °C), CC      Autoignition Temperature: 637 °F (336 °C)      LEL: None reported      UEL: None reported

**Extinguishing Media:** For small fires, use dry chemical, carbon dioxide (CO<sub>2</sub>), or regular foam. For large fires, use fog or regular foam. Since water is least effective, use it as an extinguishing agent only when the preferred measures are unavailable. However, use water spray to cool fire-exposed containers.

**Unusual Fire or Explosion Hazards:** Vapors may travel to an ignition source and flash back. Containers may explode in heat of fire. Coal tar creosote presents a vapor explosion hazard indoors, outdoors, and in sewers.

**Special Fire-fighting Procedures:** Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Immediately leave area if you hear a rising sound from venting safety device or notice any fire-caused tank discoloration. Isolate area for 1/2 mile in all directions if fire involves tank, rail car or tank truck. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Fully decontaminate or properly dispose of personal protective clothing.

**Section 5. Reactivity Data**

**Stability/Polymerization:** Coal tar creosote is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

**Chemical Incompatibilities:** Creosote oil mixed with chlorosulfonic acid in a closed container causes an increase in temperature and pressure. Conditions to Avoid: Avoid excessive heat and contact with chlorosulfonic acid.

**Hazardous Products of Decomposition:** Thermal oxidative decomposition of coal tar creosote can produce oxides of carbon and thick, black, acrid smoke.

**Section 6. Health Hazard Data**

**Carcinogenicity:** In 1990 reports, the IARC, NTP, and OSHA list coal tar creosote as a carcinogen.  
**Summary of Risks:** Coal tar creosote is toxic by inhalation, ingestion, and skin contact. It contains a variety of hydrocarbons such as phenol and polycyclic aromatic hydrocarbons such as benzo[a]pyrene, benzenanthracene, and phenol derivatives. The range of toxicity depends on the exposure concentration, amount, and duration. Effects may include irritation, burns, and several forms of cancer.  
**Medical Conditions Aggravated by Long-Term Exposure:** Chronic respiratory or skin diseases.  
**Target Organs:** Eyes, skin, bladder, kidneys, and respiratory system.  
**Primary Entry Routes:** Inhalation, ingestion, and skin contact.  
**Acute Effects:** Skin contact may cause irritation, burning, itching, redness, pigment changes, dermatitis (a rash of redness and small bumps), or rashes. Photosensitization (worsening of rash with exposure to sunlight) may occur. Inhalation may be irritating to the respiratory tract. Eye contact may cause conjunctivitis (inflammation of the eye's lining), keratitis (corneal inflammation), or corneal burns with scarring. Ingestion may result in nausea, vomiting, abdominal pain, rapid pulse, respiratory distress, and shock. Systemic absorption by any route (including skin absorption) may cause trouble breathing, thready (continuous or drawn out) pulse, dizziness, headache, nausea, vomiting, salivation, and convulsions. Exposure to large doses (particularly by ingestion) may be fatal.  
**Chronic Effects:** Dermatitis, skin cancer, and lung cancer.  
**RST AID**  
**Rescue:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do not let victim rub eyes or keep them tightly closed. Consult a physician immediately.  
**In:** Quickly remove contaminated clothing. Wash affected area with soap and flooding amounts of water for at least 15 min. For reddened or irritated skin, consult a physician.  
**Isolation:** Remove exposed person to fresh air and support breathing as needed.  
**Question:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of milk or water. Do not induce vomiting!  
**For first aid, get appropriate in-plant, paramedic, or community medical support.**  
**Note to Physicians:** Cresol may be detected in urine.

**Section 7. Spill, Leak, and Disposal Procedures**

**Spill/Leak:** Notify safety personnel. Isolate hazard area, deny entry, and stay upwind of spills. Shut off all ignition sources—no flares, smoking, or fires in hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If possible with no risk, stop leak. Water may be used to reduce vapor but it may not prevent ignition in closed spaces. For small spills, take up with earth, sand, vermiculite, or other inert, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).  
**Environmental Degradation:** Coal tar creosote is fouling to shoreline. Ecotoxicity values are: TL<sub>50</sub>, goldfish (*Carassius auratus*), 3.51 ppm/24 hr (60:40) mixture of creosote and coal tar; LD<sub>50</sub>, bob white quail (*Colinus virginianus*), 1,260 ppm/8 days (60:40) mixture of creosote and coal tar.  
**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.  
**HA Designations**  
 Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Material No. U051  
 Listed as a CERCLA Hazardous Substance\* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [\* per RCRA, Sec. 3001]  
 Listed as an EPA Extremely Hazardous Substance (40 CFR 355): Not listed  
 Listed as a SARA Toxic Chemical (40 CFR 372.65)  
**HA Designations**  
 Listed (as coal tar pitch volatiles) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

**Section 8. Special Protection Data**

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.  
**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an ABA. **Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.**  
**Face:** Wear impervious gloves, boots, aprons, and gauntlets to prevent all skin contact. Applying a layer of petroleum jelly or lanolin castor oil treatment to the face reduces vapor contact and penetration through skin. Frequent change of protective garments is an additional protective measure.  
**Ventilation:** Provide general and local exhaust ventilation systems equipped with high-efficiency particulate filters to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.<sup>(103)</sup>  
**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.  
**Contaminated Equipment:** Take particular care to avoid any contamination of drains or ventilation ducts. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.  
**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

**Section 9. Special Precautions and Comments**

**Storage Requirements:** Avoid physical damage to containers. Store in a cool, dry, well-ventilated area. Store coal tar creosote as close to area of use as possible to minimize transporting distance.  
**Engineering Controls:** Use engineering controls to keep airborne concentrations below the OSHA PEL. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Always perform synthesis and purification procedures under a local ventilation hood and make regular operational safety checks. Label doors to rooms where coal tar creosote is produced, used, or stored as containing a carcinogen. Locate emergency equipment at well-marked and clearly identified stations in case emergency escape is necessary.  
**Personal Precautions:** Preplacement and periodic medical examinations of exposed workers emphasizing respiratory, skin, liver, and kidney disorders, including comprehensive work and medical history, physical examination, CXR, PFTs, urinalysis, LFT, and sputum cytology as the attending physician considers appropriate. Educate workers about coal tar creosote's carcinogenicity and proper handling procedures to avoid exposure.  
**Other Comments:** Caution is in order when handling or sawing old creosote-treated lumber since it retains a considerable portion of creosote for up to 25 to 30 years.  
**Transportation Data (49 CFR 172.101)**  
**DOT Shipping Name:** Creosote  
**DOT Hazard Class:** Flammable liquid  
**DOT No.:** UN1136  
**DOT Label:** Flammable liquid

**DS Collection References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 142, 143, 146, 148, 153, 159

**Prepared by:** M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Mark Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 703  
1,2-Dichloroethylene

Issued: 4/90

**Section 1. Material Identification**

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**1,2-Dichloroethylene Description:** An industrial solvent composed of 60% *cis*- and 40% *trans*-isomers. Both isomers, *cis* and *trans*, are made by partial chlorination of acetylene. Used as a general solvent for organic materials, lacquers, dye extraction, thermoplastics, organic synthesis, and perfumes. The *trans*-isomer is more widely used in industry than either the *cis*-isomer or the mixture. Toxicity also varies between the two isomers.  
**Other Designations:** CAS No. 0540-59-0; C<sub>2</sub>H<sub>2</sub>Cl<sub>2</sub>; acetylene dichloride; *cis*-1,2-dichloroethylene; *sym*-dichloroethylene; *trans*-1,2-dichloroethylene, dioform.  
**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*<sup>(TM)</sup> for a suppliers list.

R	1		NFPA
I	2		
S	2		
K	1		
			HMIS
			H 2
			F 3
			R 1
			PPG*
			* Sec. 8

**Section 2. Ingredients and Occupational Exposure Limits**

1,2-Dichloroethylene, ca 100%

OSHA PEL	ACGIH TLV, 1989-90
8-hr TWA: 790 mg/m <sup>3</sup> , 200 ppm	TLV-TWA: 790 mg/m <sup>3</sup> , 200 ppm
	NIOSH REL, 1987
	790 mg/m <sup>3</sup> , 200 ppm

**Toxicity Data\***  
Rat, oral, LD<sub>50</sub>: 770 mg/kg; toxic effects not yet reviewed  
Frog, inhalation, TC<sub>Lo</sub>: 117 mg/m<sup>3</sup> inhaled for 1 hr affects the peripheral nerve and sensation (flaccid paralysis without anesthesia); behavior (excitement); lungs, thorax, or respiration (respiratory depression)

\* See NIOSH, RTECS (KV9360000), for additional toxicity data.

**Section 3. Physical Data**

Bolling Point: 119 °F/48 °C	Molecular Weight: 96.95 g/mol
Melting Point: -56 to -115 °F/-49 to -82 °C	Specific Gravity (H <sub>2</sub> O = 1 at 39 °F/4 °C): 1.27 at 77 °F/25 °C
Vapor Pressure: 180 to 264 torr at 68 °F/20 °C	Water Solubility: Insoluble
Vapor Density (Air = 1): 3.4	

**Appearance and Odor:** A colorless, low-boiling liquid with a pleasant odor.

**Section 4. Fire and Explosion Data**

Flash Point: 37 °F/2.8 °C, CC	Autoignition Temperature: 860 °F/460 °C	LEL: 5.6% v/v	UEL: 12.8% v/v
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**Extinguishing Media:** Use dry chemical, CO<sub>2</sub>, halon, water spray, or standard foam. Water may be ineffective unless used to blanket the fire.  
**Unusual Fire or Explosion Hazards:** This material's vapors are a dangerous fire hazard and moderate explosion hazard when exposed to any heat or ignition source or oxidizer.  
**Special Fire-fighting Procedures:** Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit. Vapors may travel to heat or ignition sources and flash back. Stay upwind and out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

**Section 5. Reactivity Data**

**Stability/Polymerization:** This material is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.  
**Chemical Incompatibilities:** This material is incompatible with alkalis, nitrogen tetroxide, difluoromethylene, strong oxidizers, and dihydrofluorite. When in contact with copper or copper alloys or by reaction with potassium hydroxide, explosive chloroacetylene may be released.  
**Conditions to Avoid:** Addition of hot liquid to cold 1,2-dichloroethylene may cause sudden emission of vapor that could flash back to an ignition source.  
**Hazardous Products of Decomposition:** Thermal oxidative decomposition of 1,2-dichloroethylene can produce highly toxic fumes of chlorine (Cl<sub>2</sub>).

**Section 6. Health Hazard Data**

**Carcinogenicity:** Neither the NTP, IARC, nor OSHA lists 1,2-dichloroethylene as a carcinogen.

**Summary of Risks:** 1,2-Dichloroethylene's most important effect is its irritation of the central nervous system (CNS) and narcosis. This material is toxic by inhalation, ingestion, and skin contact. It is also irritating to the eyes. The trans-isomer at 2200 ppm causes nausea, vertigo, and burning of the eyes. The trans-isomer is twice as potent as the cis-isomer. If renal effects occur, they are transient.

**Medical Conditions Aggravated by Long-Term Exposure:** None reported.

**Target Organs:** Central nervous system, eyes, respiratory system.

**Primary Entry Routes:** Inhalation, ingestion, skin and eye contact.

**Acute Effects:** Inhalation of 1,2-dichloroethylene causes narcosis, respiratory tract irritation, nausea, vomiting, tremor, weakness, central nervous depression, and epigastric (the abdomen's upper midregion) cramps. Contact with the liquid causes eye and skin (on prolonged contact) irritation. Ingestion causes slight depression to deep narcosis.

**Chronic Effects:** None reported.

**FIRST AID**

**Eyes:** Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

**Skin:** Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

**Inhalation:** Remove exposed person to fresh air and support breathing as needed. Have trained personnel administer 100% oxygen, preferably with humidification.

**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have a conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical support.

**Physician's Note:** Intravenous injections of calcium gluconate may relieve cramps and vomiting. Treat central nervous system effects symptomatically.

**Section 7. Spill, Leak, and Disposal Procedures**

**Spill/Leak:** Design and practice a 1,2-dichloroethylene spill control and countermeasure plan (SCCP). Notify safety personnel, remove all heat and ignition sources, evacuate hazard area, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Absorb small spills on paper towels. After evaporating the 1,2-dichloroethylene from these paper towels in a fume hood, burn the paper in a suitable location away from combustible material. Collect and atomize large quantities in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Follow applicable OSHA regulations (29 CFR 1910.120).

**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**EPA Designations**

Listed as a RCRA Hazardous Waste (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance\* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [\* per RCRA, Sec. 3001, per Clean Water Act, Sec. 307(a)]†

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

† Listed as 1,2-trans-dichloroethylene.

**Section 8. Special Protection Data**

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

**Respirator:** Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

**Warning:** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. 1,2-dichloroethylene attacks some forms of plastics, rubber, and coatings.

**Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.<sup>(103)</sup>

**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

**Section 9. Special Precautions and Comments**

**Storage Requirements:** Store in tightly closed containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and oxidizing materials. Outside or detached storage is preferred. If stored inside, place containers in a standard flammable liquids storage cabinet or room. Protect containers from physical damage.

**Engineering Controls:** Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. 1,2-dichloroethylene is a dangerous fire hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement questionnaires which emphasize detecting a history of chronic respiratory disease.

**Transportation Data** (49 CFR 172.101, .102): Not listed

**MSDS Collection References:** 7, 26, 38, 73, 84, 85, 87, 88, 100, 101, 103, 109, 126, 127, 136, 137

**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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# Material Safety Data Sheet

from Genium's Reference Collection  
Genium Publishing Corporation  
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No. 385

ETHYL BENZENE  
(Revision A)  
Issued: August 1978  
Revised: November 1988

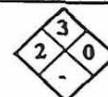
## SECTION 1. MATERIAL IDENTIFICATION 27

Material Name: ETHYL BENZENE

Description (Origin/Uses): Used as a solvent and as an intermediate in the production of styrene monomer.

Other Designations: Phenylethane; Ethylbenzol;  $C_2H_5C_6H_5$ ; CAS No. 0100-41-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.



NFPA

HMS

H 2 R 1

F 3 I 3

R 0 S 2

PPG\* K 4

\*See sect. 8

## SECTION 2. INGREDIENTS AND HAZARDS

Ethyl Benzene, CAS No. 0100-41-4

%  
Ca 100

### EXPOSURE LIMITS

OSHA PELs  
8-Hr TWA: 100 ppm, 435 mg/m<sup>3</sup>  
15-Min STEL: 125 ppm, 545 mg/m<sup>3</sup>

ACGIH TLVs, 1988-89  
TLV-TWA: 100 ppm, 435 mg/m<sup>3</sup>  
TLV-STEL: 125 ppm, 545 mg/m<sup>3</sup>

Toxicity Data\*  
Human, Inhalation,  $TC_{50}$ : 100 ppm (8 Hrs)  
Rat, Oral,  $LD_{50}$ : 3500 mg/kg

\*See NIOSH, RTECS (DA0700000), for additional data with references to reproductive, irritative, and mutagenic effects.

## SECTION 3. PHYSICAL DATA

Boiling Point: 277°F (136°C)

Melting Point: -139°F (-95°C)

Vapor Pressure: 7.1 Torrs at 68°F (20°C)

Vapor Density (Air = 1): 3.7

% Volatile by Volume: Ca 100

Molecular Weight: 106 Grams/Mole

Solubility in Water (%): Slight

Specific Gravity ( $H_2O = 1$ ): 0.86258 at 77°F (25°C)

Appearance and Odor: A clear, colorless, flammable liquid; characteristic aromatic hydrocarbon odor.

## SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method: 64°F (18°C) CC

Autoignition Temperature: 810°F (432.22°C)

LEL: 1% v/v

UEL: 6.7% v/v

Extinguishing Media: Use foam, dry chemical, or carbon dioxide to put out ethyl benzene fires. A water spray may be ineffective in extinguishing the fire, because it can scatter and spread the burning liquid. Use water spray to cool fire-exposed containers of ethyl benzene, to disperse ethyl benzene vapor, and to protect personnel attempting to stop an ethyl benzene leak. Unusual Fire or Explosion Hazards: This liquid can readily form explosive vapor-air mixtures, especially when heated. Ethyl benzene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back to its origin. Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

Stability/Polymerization: Ethyl benzene is stable in closed containers during routine operations. Hazardous polymerization cannot occur. Chemical Incompatibilities: Hazardous chemical reactions can occur between ethyl benzene and strong oxidizing agents, acids, ammonia, and bases. Conditions to Avoid: Avoid any exposure to sources of ignition such as heat, sparks, open flame, and lighted tobacco products, etc., and to incompatible chemicals. Use caution when entering confined spaces, particularly low-lying areas where explosive concentrations of ethyl benzene vapor may be present. Provide good ventilation to such areas to prevent the concentration of this vapor. Hazardous Products of Decomposition: Thermal-oxidative degradation can include toxic gases such as carbon monoxide and/or aromatic hydrocarbon gases.

## SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Ethyl benzene is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Ethyl benzene vapor is severely irritating to the eyes and to the mucous membranes of the respiratory system. Sustained inhalation of excessive levels can cause depression of the central nervous system (CNS) characterized by dizziness, headache, narcosis, and coma. Skin contact with liquid ethyl benzene causes irritation; dermatitis and defatting can also develop. The acute oral toxicity of ethyl benzene is low; however, ingestion of it presents a serious aspiration hazard. Aspiring even a small amount into the lungs can result in extensive edema (lungs filled with fluid) and hemorrhaging of the lung tissue. No systemic effects are expected at the levels that produce pronounced, unignorable, disagreeable skin and eye irritation. The TLVs cited in section 2 are set to prevent this intolerable irritation. Medical Conditions Aggravated by Long-Term Exposure: None reported. Target Organs: Skin, eyes, respiratory system, and CNS. Primary Entry: Inhalation, skin contact. Acute Effects: Irritation of the skin, eyes, and respiratory system. Also, cardiac-rhythm disturbance due to sensitization; acute bronchitis, bronchospasm, pulmonary and laryngeal edema; euphoria; headache; giddiness; dizziness; and incoordination, as well as possible depression; confusion; and coma. Chronic Effects: None reported. First Aid: Eyes. Immediately

**SECTION 6. HEALTH HAZARD INFORMATION, cont.**

flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected area with plenty of water, then wash it with soap and water. Inhalation. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Ingestion. Unlikely. Should this type of exposure occur, the aspiration hazard must be considered. Do not induce vomiting unless directed to do so by a physician. To prevent aspiration by spontaneous vomiting, keep the victim's head low (between his or her knees). Get medical help (in plant, pararegional, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. Note to Physician: Professional judgment is required as to whether or not to induce vomiting because of the possibility of aspiration. A gastric lavage may be administered, followed by saline catharsis, if this procedure is appropriate to the specific incident. Monitor cardiac and pulmonary functions.

**SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES**

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

SHA Designations

listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

PA Designations (40 CFR 302.4)

ERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

**SECTION 8. SPECIAL PROTECTION INFORMATION**

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow SHA eye- and face-protection regulations (29 CFR 1910.133). Respirator: Wear a NIOSH-approved respirator per Genium reference 88 or the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134) for emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. Warning: Air-purifying respirators will not protect workers in oxygen-deficient atmospheres. Other: Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. Ventilation: Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. Comments: Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do not eat, drink, or smoke in any work area. Do not inhale ethyl benzene vapor.

**SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS**

Storage/Segregation: Store ethyl benzene in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. Special Handling/Storage: Outside, isolated, detached, or remote storage is recommended for large quantities of ethyl benzene. Isolate bulk storage areas from acute fire hazards. Engineering Controls: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations. Other: Use safety procedures for transferring small amounts of ethyl benzene.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Ethyl Benzene

DOT Hazard Class: Flammable Liquid

DOT No. UN1175

DOT Label: Flammable Liquid

DOT Packaging Exceptions: 49 CFR 173.118

DOT Packaging Requirements: 49 CFR 173.119

IO Shipping Name: Ethylbenzene

IO Hazard Class: 3.2

IO Label: Flammable Liquid

FDG Packaging Group: II

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: W Silverman, MD

# Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 310  
METHYLENE CHLORIDE  
(Revision F)

Issued: September 1985  
Revised: November 1988

## SECTION 1. MATERIAL IDENTIFICATION

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Material Name: METHYLENE CHLORIDE

Description (Origin/Uses): Used widely in paint removers, as a solvent for plastics, as a degreasing agent, in propellant mixtures for aerosol sprays, and as a blowing agent in foams.

Other Designations: Dichloromethane; Freon 30<sup>®</sup>; Methane Dichloride; Methylene Bichloride; Methylene Dichloride; CH<sub>2</sub>Cl<sub>2</sub>; CAS No. 0075-09-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.



HMS  
H 2 R 1 NFPA  
F 1 I 3  
R 0 S 3  
PPG\* K 1  
\*See sect. 8

## SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

Methylene Chloride, ca 100%

OSHA PEL  
8-Hour TWA: 500 ppm  
Ceiling: 1000 ppm Acceptable Maximum Peak  
above the Ceiling: 2000 ppm for 5 Minutes in  
Any 2-Hour Period

ACGIH TLV, 1988-89  
TLV-TWA: 50 ppm, 175 mg/m<sup>3</sup>  
(Adopted 1988-89)

Toxicity Data\*  
Rat, Oral, LD<sub>50</sub>: 2136 mg/kg  
Human, Inhalation, TC<sub>Lo</sub>: 500 ppm (8 Hours)

\*See NIOSH, RTECS (PA8050000), for additional data with references to irritative, reproductive, mutagenic, and tumorigenic effects.

## SECTION 3. PHYSICAL DATA

Boiling Point: 103.55°F (39.75°C) at 76 Torr  
Melting Point: -142°F (-96.7°C)  
Vapor Density (Air = 1): 2.9  
Vapor Pressure: 440 Torr at 77°F (25°C)

Molecular Weight: 84.94 Grams/Mole  
Solubility in Water (%): 1% by Weight  
Specific Gravity (H<sub>2</sub>O = 1): 1.3255 at 68°F (20°C)  
% Volatile by Volume: Ca 100

Appearance and Odor: A clear, colorless, volatile liquid; distinctive, penetrating, ethereal odor. The odor will not serve as a useful warning property because concentrations of 100 ppm are not easily perceptible. Most persons can detect this odor at above 300 ppm.

## SECTION 4. FIRE AND EXPLOSION DATA

Flash Point\* Autoignition Temperature: 1033°F (556°C) LEL: 12% v/v UEL: 19% v/v

Extinguishing Media: \*Methylene chloride is not flammable under ordinary conditions. However, flammable vapor-air mixtures can form at approximately 212°F (100°C). Use water spray to cool fire-exposed containers and to flush spills away from exposures. Use extinguishing agents that will put out the surrounding fire. Unusual Fire or Explosion Hazards: Methylene chloride vapor is heavier than air and may collect and concentrate in low-lying, confined spaces. The high vapor pressure of methylene chloride means that when it is spilled, its vapor concentration in air can increase rapidly. If this vapor is heated, an explosion hazard is associated with the vapor-air mixture. Containers of this material may rupture violently if they are involved in fires. Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

Stability/Polymerization: Methylene chloride is stable in closed containers during routine operations. Hazardous polymerization cannot occur. Chemical Incompatibilities: Methylene chloride can react dangerously with nitrogen tetroxide, liquid oxygen, potassium, sodium, sodium-potassium alloys, lithium, potassium hydroxide with N-methyl-N-nitroso urea, potassium t-butoxide, and finely powdered aluminum and magnesium. Conditions to Avoid: Avoid all exposure to sources of ignition, heat, and incompatible chemicals. Prolonged exposure to water may cause hydrolysis to highly corrosive hydrochloric acid when the temperature is above 140°F (60°C). In oxygen-enriched atmospheres or when heated (>212°F [100°C]), methylene chloride vapor can be readily ignited. Hazardous Products of Decomposition: Exposure to high temperature (from open flame, hot surfaces, uninsulated steam lines, welding arcs, etc.) can produce toxic and corrosive thermal-oxidative products of decomposition such as hydrogen chloride, carbon monoxide, and even small quantities of phosgene gas, which is extremely poisonous.

## SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Methylene chloride is listed as a suspected human carcinogen by the ACGIH (which classifies it as a group A2 carcinogen). Summary of Risks: Accidental contact of liquid methylene chloride with skin or eyes causes painful irritation and possible burns if not promptly removed. Exposure by way of contaminated gloves, clothing, or paint remover formulations can produce these same irritant effects. Long-term exposure to mild or moderate doses of methylene chloride may cause a delayed (24 to 48 hours) onset of dizziness, headache, mental confusion, slurred speech, double vision, and sleeplessness. Medical recovery can be slow. Overexposure to methylene chloride can cause elevated levels of carboxy hemoglobin in the blood (this same effect results from overexposure to carbon monoxide). Medical Conditions Aggravated by Long-Term Exposure: None reported. Target Organs: Skin, eyes, respiratory system, CNS, liver, kidneys, and blood. Primary Entry: Inhalation, skin contact/absorption. Acute Effects: Headache, giddiness, stupor, irritability, fatigue, tingling in the limbs, and narcosis that is not usually fatal if the exposure is terminated before anesthetic death occurs. Chronic Effects: The ACGIH classification of this material as a suspected human carcinogen implies that cancer is a possible effect of chronic exposure to methylene chloride. FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with

**SECTION 6. HEALTH HAZARD INFORMATION, cont.**

flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected area with flooding amounts of water and then wash it with soap and water. Inhalation. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Note to Attending Physician: Do not administer adrenalin. Ingestion. Unlikely. Should this type of exposure occur, do not induce vomiting because of the danger of aspiration. If spontaneous vomiting should occur, position the exposed person's head below his or her trunk to resist aspiration. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. Note to Physician: Absorbed methylene chloride is stored in body fat and metabolizes to carbon monoxide. This produced carbon monoxide increases and sustains carboxyhemoglobin levels in the blood, which concomitantly reduces the oxygen-carrying capacity of the blood. NIOSH advises preplacement and annual medical exams that emphasize liver, kidney, eye, skin, CNS, and respiratory system functions and a complete blood count. Simultaneous exposure to tobacco smoke, alcohol, and carbon monoxide, along with heavy manual labor, increases the body burden of a worker as well as the toxic hazards of the methylene chloride. In significant exposures, serum methylene chloride levels are of no clinical importance. Neurologic and hepatic status as well as carboxy hemoglobin should be monitored.

**SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES**

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against this liquid's contact with the skin or eyes as well as inhalation of its vapor. Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, NO. U080

CECLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), § 307 (a), and the Resource Conservation and Recovery Act (RCRA), § 3001.

**SECTION 8. SPECIAL PROTECTION INFORMATION**

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). Respirator: Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. Warning: Air-purifying respirators will not protect workers in oxygen-deficient atmospheres. Other: Wear impervious neoprene, PVA, or Viton gloves, boots, aprons, and gauntlets, etc., to prevent any skin contact with liquid methylene chloride. Ventilation: Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the exposure limits cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Floor or sump ventilation may be necessary. Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. Other: Because the health effects of carbon monoxide and methylene chloride are additive (see sect. 6), workplaces should be equipped with automatic sensing equipment that identifies workroom atmospheric levels of both of these materials. Comments: Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do not eat, drink, or smoke in any work area. Do not inhale methylene chloride vapor.

**SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS**

Storage/Segregation: Store methylene chloride in closed, moisture-proof containers in a cool, dry, well-ventilated area away from sources of ignition, strong oxidizers, caustics, and incompatible chemicals (see sect. 5). Protect containers from physical damage. Special Handling/Storage: Prevent moist air from entering storage containers. Provide ventilation at the floor level in storage areas because methylene chloride vapor is denser than air. Installation of a dryer and a safety seal on each tank is recommended. Aluminum is not recommended for use as a storage material; appropriate storage materials include galvanized iron, black iron, or steel. Engineering Controls: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks.

**Transportation Data (49 CFR 172.101-2)**

DOT Shipping Name: Dichloromethane or Methylene Chloride

DOT Hazard Class: ORM-A

ID No. UN1593

DOT Packaging Requirements: 49 CFR 173.605

DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: Dichloromethane

IMO Hazard Class: 6.1

IMO Label: Saint Andrew's Cross (X)\*

IMDG Packaging Group: III

\*Harmful-Stow away from Foodstuffs.

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Material Safety Data Sheets Collection:

Sheet No. 311  
Methyl Chloroform

Issued: 11/75 Revision: F, 3/92 Errata: 6/92

Section 1. Material Identification		38						
<p>Methyl Chloroform (C<sub>2</sub>H<sub>3</sub>Cl<sub>3</sub>) Description: Derived by catalytic addition of hydrogen chloride to 1,1-dichloroethylene or by re-fluxing chlorine monoxide with carbon tetrachloride and chloroethane. Available in technical and solvent grades which differ only in the amount of stabilizer added to prevent metal parts corrosion. Used as a solvent for oils, waxes, tars, cleaning precision instruments, and pesticides; as a component of inks and drain cleaners; in degreasing metals, and textile processing. In recent years, methyl chloroform has found widespread use as a substitute for carbon tetrachloride.</p> <p>Other Designations: CAS No. 71-55-6, α-trichloroethane; Inhibisol; 1,1,1-trichloroethane; Strobane.</p> <p>Manufacturer: Contact your supplier or distributor. Consult latest <i>Chemical Week Buyers' Guide</i><sup>(73)</sup> for a suppliers list.</p> <p>Cautions: Methyl chloroform is a skin, eye, and respiratory tract irritant and can become narcotic with an anesthetic effect at high concentrations.</p> <p>* Data on skin absorption via methyl chloroform is conflicting.<sup>(133)</sup> Some studies show definite absorption where others don't.</p>		<p>R 1 Genium I 2 S 2* K 1</p>  <p>HMIS H 2 F 1 R 1 PPG* * Sec. 8</p>						
Section 2. Ingredients and Occupational Exposure Limits								
<p>Methyl chloroform, ca 92 to 97%*</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 33%;"> <p>1990 OSHA PELs 8-hr TWA: 350 ppm (1900 mg/m<sup>3</sup>) 15-min STEL: 450 ppm (2450 mg/m<sup>3</sup>)</p> </td> <td style="width: 33%;"> <p>1991-92 ACGIH TLVs TWA: 350 ppm (1910 mg/m<sup>3</sup>) STEL: 450 ppm (2460 mg/m<sup>3</sup>)</p> </td> <td style="width: 33%;"> <p>1985-86 Toxicity Data† Human, oral, TD<sub>01</sub>: 670 mg/kg produced diarrhea, nausea, and vomiting Human, inhalation, LC<sub>01</sub>: 27 g/m<sup>3</sup>/10 min; toxic effects not yet reviewed Man, eye: 450 ppm/8 hr produced irritation Rat, inhalation, TC<sub>01</sub>: 2100 ppm/24 hr for 14 days prior to mating and from 1 to 20 days of pregnancy produced specific developmental abnormalities of the musculoskeletal system</p> </td> </tr> <tr> <td> <p>1990 IDLH Level 1000 ppm</p> </td> <td> <p>1990 DFG (Germany) MAKs TWA: 200 ppm (1080 mg/m<sup>3</sup>) Half-life: 2 hr to shift length Peak Exposure Limit: 1000 ppm/30 min (average value)/2 per shift</p> </td> <td></td> </tr> </table> <p>* Methyl chloroform usually contains inhibitors (3 to 8%) to prevent corrosion of aluminum and some other metals. Typical inhibitors are nitromethane, butylene oxide, secondary butyl alcohols, ketones, and glycol diesters. † See NIOSH, RTECS (KJ2975000), for additional irritation, mutation, reproductive, and toxicity data.</p>			<p>1990 OSHA PELs 8-hr TWA: 350 ppm (1900 mg/m<sup>3</sup>) 15-min STEL: 450 ppm (2450 mg/m<sup>3</sup>)</p>	<p>1991-92 ACGIH TLVs TWA: 350 ppm (1910 mg/m<sup>3</sup>) STEL: 450 ppm (2460 mg/m<sup>3</sup>)</p>	<p>1985-86 Toxicity Data† Human, oral, TD<sub>01</sub>: 670 mg/kg produced diarrhea, nausea, and vomiting Human, inhalation, LC<sub>01</sub>: 27 g/m<sup>3</sup>/10 min; toxic effects not yet reviewed Man, eye: 450 ppm/8 hr produced irritation Rat, inhalation, TC<sub>01</sub>: 2100 ppm/24 hr for 14 days prior to mating and from 1 to 20 days of pregnancy produced specific developmental abnormalities of the musculoskeletal system</p>	<p>1990 IDLH Level 1000 ppm</p>	<p>1990 DFG (Germany) MAKs TWA: 200 ppm (1080 mg/m<sup>3</sup>) Half-life: 2 hr to shift length Peak Exposure Limit: 1000 ppm/30 min (average value)/2 per shift</p>	
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<p>1990 IDLH Level 1000 ppm</p>	<p>1990 DFG (Germany) MAKs TWA: 200 ppm (1080 mg/m<sup>3</sup>) Half-life: 2 hr to shift length Peak Exposure Limit: 1000 ppm/30 min (average value)/2 per shift</p>							
Section 3. Physical Data								
<p>Boiling Point: 165 °F (75 °C) Freezing Point: -22 °F (-30 °C) Vapor Pressure: 100 mm Hg at 68 °F (20 °C) Vapor Density (air = 1): 4.55 Corrosivity: Readily corrodes aluminum and its alloys Refraction Index: 1.43765 at 69.8 °F (21 °C) Viscosity: 0.858 cP at 68 °F (20 °C) Appearance and Odor: Colorless liquid with a sweetish, chloroform-like odor. The odor threshold is 44 ppm.</p> <p>Molecular Weight: 133.42 Density: 1.3376 at 68/39.8 °F (20/4 °C) Water Solubility: Insoluble Other Solubilities: Soluble in acetone, alcohol, ether, benzene, carbon tetrachloride, and carbon disulfide % in Saturated Air: 16.7% at 77 °F (25 °C) Relative Evaporation Rate (butyl acetate = 1): 12.8</p>								
Section 4. Fire and Explosion Data								
<p>Flash Point: None (in conventional CC tests)   Autoignition Temperature: 932 °F (500 °C)   LEL: 7% v/v   UEL: 16% v/v</p> <p>Extinguishing Media: Noncombustible liquid whose vapor burns in the presence of excess oxygen or a strong ignition source. For small fires, use dry chemical or carbon dioxide (CO<sub>2</sub>). For large fires use fog or regular foam. If these materials are unavailable, a water spray may be used but be aware that water reacts slowly with methyl chloroform to release hydrochloric acid.</p> <p>Unusual Fire or Explosion Hazards: Vapors are heavier than air and may travel to a strong ignition source and flash back. Air/vapor mixtures may explode when heated. Container may explode in heat of fire. Exposure to open flames or arc welding can produce hydrogen chloride and phosgene.</p> <p>Special Fire-fighting Procedures: Methyl chloroform's burning rate is 2.9 mm/min. Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides limited protection. Wear clothing specifically recommended by the manufacturer for use in fires involving methyl chloroform. Apply cooling water to container sides until after fire is extinguished. Stay away from ends of tanks. Isolate area for 1/2 mile if fire involves tank, truck, or rail car. Be aware of runoff from fire control methods. Do not release to sewers or waterways.</p>								
Section 5. Reactivity Data								
<p>Stability/Polymerization: Methyl chloroform is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can occur in contact with aluminum trichloride.</p> <p>Chemical Incompatibilities: Methyl chloroform is incompatible with sodium hydroxide, nitrogen tetroxide, oxygen (liquid or gas), strong oxidizers, and chemically active metals like aluminum, zinc, and magnesium powders; reacts violently with caustics to form dichloroacetylene; reacts slowly with water to form hydrochloric acid; forms shock sensitive mixtures with potassium; and polymerizes in contact with aluminum trichloride.</p> <p>Conditions to Avoid: Exposure to moisture, strong ignition sources, and arc-welding units, and contact with incompatibles.</p> <p>Hazardous Products of Decomposition: Thermal oxidative decomposition (temperatures &gt;500 °F, contact with hot metals, or under UV rays) of methyl chloroform can produce carbon dioxide (CO<sub>2</sub>) and toxic dichloroacetylene, hydrogen chloride, and phosgene gases.</p>								
Section 6. Health Hazard Data								
<p>Carcinogenicity: The IARC (Class 3, inadequate evidence),<sup>(164)</sup> NTP,<sup>(142)</sup> and OSHA<sup>(164)</sup> do not list methyl chloroform as a carcinogen.</p> <p>Summary of Risks: Methyl chloroform is considered one of the least toxic of the liquid chlorinated hydrocarbons. It is irritating to eyes, skin, and respiratory tract. Although low in systemic toxicity, methyl chloroform is an anesthetic capable of causing death at high concentrations (&gt;15,000 ppm), generally in poorly ventilated, enclosed areas. Quick and complete recovery is observed after prompt removal of unconscious persons from area of exposure. Like many other solvents, methyl chloroform sensitizes the heart to epinephrine (blood pressure-raising hormone) and may induce cardiac arrhythmias and arrest.</p> <p>Medical Conditions Aggravated by Long-Term Exposure: None reported.</p> <p>Target Organs: Skin, eyes, central nervous (CNS) and cardiovascular (CVS) systems.</p>								

Continue on next page

**Section 6. Health Hazard Data, continued**

**Primary Entry Routes:** Inhalation, skin contact. **Acute Effects:** Methyl chloroform defats the skin causing irritation, redness, dryness, and scaling. Contact with eyes produces irritation and mild conjunctivitis. Vapor inhalation can cause headache, dizziness, equilibrium disturbances, and in high concentrations may lead to CNS depression, unconsciousness, and coma. During a 60-min exposure period these effects are observed: 100 ppm is the observed odor threshold, at 500 ppm there is obvious odor and decreased reaction time, 1000 ppm causes slight equilibrium loss, at 5000 ppm there is definite incoordination, and 20,000 ppm produces surgical strength anesthesia with possible death. Mild liver and kidney dysfunction may occur after CNS depression recovery. Although unlikely, if ingestion occurs, symptoms include nausea, vomiting, diarrhea, and possible esophageal burns. The acute lethal human dose is ~500 to 5000 mg/kg. **Chronic Effects:** None reported.

**FIRST AID**

**Eyes:** Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do not allow victim to rub or keep eyes tightly shut. Consult a physician immediately. **Skin:** Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center, and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water to dilute. When deciding whether to induce vomiting, carefully consider amount ingested, time since ingestion, and availability of medical help. If large amounts are recently ingested (absorption into the body is not yet likely to have occurred), and medical help or transportation to a medical facility is not readily available, induce vomiting. Otherwise, vomiting is not recommended since aspiration of vomitus can produce chemical pneumonitis. **Note to Physicians:** Do not use adrenaline or sympathomimetic amines in treatment because of the increased cardiac sensitivity involved.

**Section 7. Spill, Leak, and Disposal Procedures**

**Spill/Leak:** Immediately notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources. If possible without risk, shut off leak. Cleanup personnel should wear fully encapsulating vapor-protective clothing. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material. Using nonsparking tools, place in suitable containers for disposal or reclamation. For large spills, dike far ahead of liquid spill for later disposal or reclamation. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120).

**Environmental Transport:** In water, methyl chloroform's half-life is hours to weeks depending on wind and mixing conditions. It is very persistent in groundwater. On land it volatilizes due to its high vapor pressure and leaches extensively. When released to the atmosphere, methyl chloroform can be transported long distances and returned to earth via rain. It is slowly degraded by reaction with hydroxyl radicals and has a half-life of 6 months to 5 years. The Natural Resources Defense Council reported recently that methyl chloroform depletes ozone.

**Toxicity Values:** *Pimephales promelas* (fathead minnow), LC<sub>50</sub>: 52.8 mg/L/96 hr; *Poecilia reticulata* (guppy), LC<sub>50</sub>: 133 ppm/7 day.

**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**PA Designations**

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U226  
 Listed as a CERCLA Hazardous Substance\* (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [\* per RCRA, Sec. 3001, CWA, Sec. 307(a), and CAA, Sec. 112]  
 RCRA Extremely Hazardous Substance (40 CFR 355): Not listed  
 Listed as a SARA Toxic Chemical (40 CFR 372.65)

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

**Section 8. Special Protection Data**

**Goggles:** Wear splash-proof, protective chemical safety goggles or faceshields, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

**Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact. Viton and butyl rubber [with breakthrough times (BTs) of >8 hr and 4 to 7.9 hr, respectively] are recommended materials for protective gear. Do not use neoprene, polyvinyl chloride (PVC), natural rubber, or polyethylene because these materials have a BT of <1 hr.

**Ventilation:** Provide general and local exhaust (in some cases, explosion-proof) ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.<sup>(103)</sup>

**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

**Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.

**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

**Section 9. Special Precautions and Comments**

**Storage Requirements:** Prevent physical damage to containers. Store in cool, dry, well-ventilated (use pressure-vacuum ventilation) area away from ignition sources, arc-welding operations, and incompatibles (Sec. 5). Regularly monitor inhibitor levels. Do not store in aluminum containers or use pressure-spraying equipment when methyl chloroform is involved.

**Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground and bond all equipment used in methyl chloroform manufacturing, use, storage, transfer, and shipping.

**Administrative Controls:** Consider replacement and periodic medical exams of exposed workers that emphasize CNS, CVS, liver and skin.

**Transportation Data (49 CFR 172.101, .102)**

DOT Shipping Name: 1,1,1-Trichloroethane  
 DOT Hazard Class: ORM-A  
 ID No.: UN2831  
 DOT Label: None  
 DOT Packaging Exceptions: 173.505  
 DOT Packaging Requirements: 173.605

IMO Shipping Name: 1,1,1-Trichloroethane  
 IMO Hazard Class: 6.1  
 ID No.: UN2831  
 IMO Label: St. Andrews Cross  
 IMDG Packaging Group: III

MSDS Collection References: 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 148, 153, 159, 162, 163, 164

Prepared by: M Gannon, BA; Industrial Hygiene Review: D Wilson, CHH; Medical Review: AC Darlington, MPH, MD; Edited by: JR Stuart, MS

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**SECTION 1. MATERIAL IDENTIFICATION** 20

**MATERIAL NAME:** METHYL ETHYL KETONE

**OTHER DESIGNATIONS:** MEK, Butanone, 2-Butanone, Ethyl Methyl Ketone,  $\text{CH}_3\text{COCH}_2\text{CH}_3$ ,  
 ASTM D740, CAS #0078-93-3

**MANUFACTURER/SUPPLIER:** Available from many suppliers, including:  
 Ashland Chemical Company, Industrial Chemicals & Solvents Div., PO Box 2219, Columbus, OH 43216;  
 Telephone: (614) 889-3844

HMIS

H 1

F 3

R 1

PPE\*

\* See Sect. 8



**SECTION 2. INGREDIENTS AND HAZARDS**

	%	HAZARD DATA
Methyl Ethyl Ketone; ( $\text{C}_4\text{H}_8\text{O}$ )	ca 100	8-hr TWA 200 ppm* or 590 mg/m <sup>3</sup>  Human, Inhalation TCLo: 100 ppm/5 min.  Rat, Oral, LD <sub>50</sub> : 2.7 g/kg  Rabbit, Skin, LD <sub>50</sub> : 13 g/kg
* Current OSHA PEL and ACGIH (1985-86) TLV. NIOSH (1978) proposed a 10-hr TWA of 200 ppm.		

**SECTION 3. PHYSICAL DATA**

Boiling Point, 1 atm ... 176°F (80°C)	Specific Gravity (20/4°C) ... 0.805
Vapor Pressure @ 20°C ... 72	Volatiles, vol. % ... ca 100
Vapor Density (Air = 1) ... 2.5	Evaporation Rate (BuAc = 1) ... 5.7
Viscosity @ 25°C, cp ... 0.40	Freezing Point ... -122.8°F (-86°C)
Solubility in Water @ 20°C, wt. % ... 27.1	Molecular Weight ... 72.12

**Appearance and odor:** Colorless liquid with a moderately sharp, fragrant, mintlike odor. Unfatigued, odor recognition threshold (100% of test panel) is 6-10 ppm.

**SECTION 4. FIRE AND EXPLOSION DATA**

			LOWER	UPPER
Flash Point and Method	Autoignition Temp.	Flammability Limits In Air		
20°F (-6.7°C) CC	960°F (516°C)	% by Vol.	1.8	10.0

**EXTINGUISHING MEDIA:** Dry chemical, carbon dioxide, alcohol foam, water spray. Use water spray to disperse vapors and to flush spills away from exposures. A stream of water can scatter flames. Water may be ineffective in extinguishing fire but should be used to help control fire and keep fire-exposed containers cool. Methyl ethyl ketone is a dangerous fire hazard and a moderate explosion hazard when exposed to heat or flame. Vapors can flow along surfaces to a distant ignition source and flash back.

Fire fighters should wear self-contained breathing apparatus in enclosed areas.

**SECTION 5. REACTIVITY DATA**

Methyl ethyl ketone is a stable material in closed containers at room temperature under normal storage and handling conditions. It does not polymerize.

This material is an OSHA Class IB Flammable Liquid. It is incompatible with oxidizing agents that can cause spontaneous ignition and violent reaction. Ignition is caused by reaction with potassium t-butoxide.

Thermal-oxidative degradation products can include carbon monoxide, carbon dioxide, and various hydrocarbons.

MEK can attack many plastics, resins, and rubber.





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Material Safety Data Sheets Collection:

Sheet No. 304  
Methyl Isobutyl Ketone

Issued: 9/79 Revision: D, 6/92

### Section 1. Material Identification

**Methyl Isobutyl Ketone** [ $\text{CH}_3\text{COCH}_2\text{CH}(\text{CH}_3)_2$ ] **Description:** Derived by hydrogenation of mesityl oxide over nickel at 320 to 374 °F (160 to 190 °C), by oxidation of methyl isobutyl carbinol, or by reacting sodium acetoacetic ester with isopropyl bromide and treating the resulting 2-isopropylacetoacetic ester with dilute acid to saponify the ester and decarboxylate the resulting keto acid. Used as a solvent for gums, resins, nitrocellulose, paints, varnishes, lacquers (frequently blended with methyl ethyl ketone), and protective coatings; in organic synthesis, in the manufacture of methyl amyl alcohol and antibiotics, in dewaxing mineral oils, in extraction processes (including uranium from fission products and rare metal extraction), in synthetic flavoring (fruit flavors and rum cheese), and in the plastic and petroleum industries.

**Other Designations:** CAS No. 108-10-1, hexone, isopropylacetone, 4-methyl-2-oxopentane, 4-methyl-2-pentanone, MIBK.

**Manufacturer:** Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*<sup>(73)</sup> for a suppliers list.

R	1	NFPA
I	3	
S	2	
K	4	
HMIS		
H 2		
F 3		
R 0		
PPG*		
* Sec. 8		

**Cautions:** Methyl isobutyl ketone is a systemic irritant by inhalation and is very irritating to the eyes, skin, and mucous membranes. At high concentrations it can become narcotic. This liquid is highly flammable.

### Section 2. Ingredients and Occupational Exposure Limits

Methyl isobutyl ketone, technical grade ca 98.5%

1991 OSHA PELs	1991-92 ACGIH TLVs	1985-86 Toxicity Data*
8-hr TWA: 50 ppm (205 mg/m <sup>3</sup> )	TWA: 50 ppm (205 mg/m <sup>3</sup> )	Human, eye: 200 ppm/15 min produced irritation
15-min STEL: 75 ppm (300 mg/m <sup>3</sup> )	STEL: 75 ppm (307 mg/m <sup>3</sup> )	Rabbit, skin: 500 mg/24 hr produced mild irritation
1990 IDLH Level	1990 DFG (Germany) MAKs	Rat, oral, LD <sub>50</sub> : 2080 mg/kg; toxic effects not yet reviewed
3000 ppm	100 ppm (400 mg/m <sup>3</sup> )	Rat, inhalation, LC <sub>50</sub> : 8000 ppm/4 hr; toxic effects not yet reviewed
1990 NIOSH RELs	Half-life: 2 hr to end of shift	
TWA: 50 ppm (205 mg/m <sup>3</sup> )	Peak Exposure Level: 500 ppm,	
STEL: 75 ppm (307 mg/m <sup>3</sup> )	30 min average value, maximum of 2 peaks per shift	

\* See NIOSH, RTECS (SA9275000), for additional irritation and toxicity data.

### Section 3. Physical Data

Boiling Point: 242 °F (117 °C) at 760 mm Hg	Molecular Weight: 100.16
Freezing Point: -120 °F (-84.7 °C)	Specific Gravity: 0.802 at 68 °F (20 °C)
Vapor Pressure: 15.7 mm Hg at 68 °F (20 °C)	Water Solubility: Floats and slowly mixes, (1.9%)
Saturated Vapor Density (air = 1.2 kg/m <sup>3</sup> ): 1.26 mg/m <sup>3</sup> or 0.078 lbs/ft <sup>3</sup>	Other Solubilities: Miscible in alcohol, acetone benzene, chloroform, and ether.
Refraction Index: 1.3962 at 68 °F (20 °C)	Surface Tension: 23.6 dyne/cm at 68 °F (20 °C)
Odor Threshold: 0.1 to 16 ppm	
Relative Evaporation Rate (ether = 1): 5.6	
Appearance and Odor: Colorless liquid with a sweet, camphor-like odor.	

### Section 4. Fire and Explosion Data

Flash Point: 64 °F (18 °C) CC	Autoignition Temperature: 840 °F (448 °C)	LEL: 1.2% v/v (200 °F)	UEL: 8% v/v (200 °F)
Extinguishing Media: A Class 1B or 1C flammable liquid (dependent on exact flash point). For small fires, use dry chemical, carbon dioxide (CO <sub>2</sub> ), or "alcohol-resistant" foam. For large fires, use fog, or "alcohol-resistant" foam. Water spray may be ineffective since MIBK has a tendency to float on water before mixing.			
Unusual Fire or Explosion Hazards: Vapors form explosive mixtures with air and may travel to a source of ignition and flash back. Container may explode in heat of fire. MIBK poses a vapor explosion hazard indoors, outdoors, and in sewers.			
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection. If possible without risk, move container from fire area. Apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw from area immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.			

### Section 5. Reactivity Data

**Stability/Polymerization:** Methyl isobutyl ketone is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

**Chemical Incompatibilities:** Incompatible with strong oxidizers and potassium *tert*-butoxide, and can react vigorously with reducing materials. MIBK may form explosive peroxides with air.

**Conditions to Avoid:** Exposure to heat and ignition sources and contact with incompatibles.

**Hazardous Products of Decomposition:** Thermal oxidative decomposition of methyl isobutyl ketone can produce carbon dioxide (CO<sub>2</sub>).

### Section 6. Health Hazard Data

**Carcinogenicity:** The IARC,<sup>(164)</sup> NTP,<sup>(169)</sup> and OSHA<sup>(164)</sup> do not list methyl isobutyl ketone as a carcinogen.

**Summary of Risks:** Methyl isobutyl ketone exerts most of its toxicity on the central nervous system (CNS) causing a narcotic effect. It may also affect the cardiovascular system and some studies have reported liver and kidney damage. MIBK is irritating to the eyes, mucous membranes and skin. Repeated animal doses by various routes indicate that MIBK is not neurotoxic, although one report (Lancet, No. 8138, dated Aug 18, 1979; pg 363) suggests possible peripheral neuropathies. In light of this data possible nerve damage should not be disregarded.

**Medical Conditions Aggravated by Long-term Exposure:** None reported

Continue on next page

**Section 6. Health Hazard Data, continued**

**Target Organs:** CNS, eyes, respiratory system, skin.

**Primary Entry Routes:** Inhalation, eye and skin contact, ingestion.

**Acute Effects:** Inhalation is the most hazardous route of exposure. Symptoms include irritation of the eyes and mucous membranes, excitability, headache, appetite loss, sore throat, visual disturbance, pale complexion, tiredness, nausea and vomiting. In high concentrations symptoms progress to CNS depression with drunken behavior, staggering/coordination loss, mental confusion, stupor, loss of consciousness, coma, and death. Some animals exposed to high levels showed fatty livers, and congestion of the brain, lungs, and spleen. Skin contact is irritating and if spilled and allowed to remain on clothing, redness and smarting can occur. Splashing in the eyes, causes irritation with burning and stinging, watering eyes, lid inflammation, and painful sensitivity to light. The TWA is set to prevent irritation effects. Ingestion is unlikely but if it occurs it will cause gastrointestinal irritation followed by inhalation symptoms.

**Chronic Effects:** Repeated skin contact causes defatting and can lead to dermatitis.

**FIRST AID**

**Eyes:** Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do not allow victim to rub or keep eyes tightly shut. Immediately consult a physician.

**Skin:** Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

**Inhalation:** Remove exposed person to fresh air and support breathing as needed.

**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that conscious and alert person drink 1 to 2 glasses of water, then induce vomiting with Ipecac syrup.

**After first aid, get appropriate in-plant, paramedic, or community medical support.**

**Note to Physicians:** Treatment is symptomatic and supportive.

**Section 7. Spill, Leak, and Disposal Procedures**

**Spill/Leak:** Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against inhalation and skin and eye contact. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and using nonsparking tools, place in suitable containers. For large spills, dike far ahead of liquid spill for later disposal. This material vaporizes easily! Take appropriate precautions. Prevent entry into drains, sewers, and other confined spaces (explosion hazard). For water spills, use oil skimming equipment and apply sorbent foams. Use carbon or peat on dissolved portion. Follow applicable OSHA regulations (29 CFR 1910.120).

**Environmental Degradation:** In air, MIBK is subjected to direct photolysis (half-life of 15 hr in sunlight) or reaction with hydroxyl radicals (half-life of 16 to 17 hr). It may also react with nitrogen oxides in photochemical smog-situations. In water, it is removed by direct photolysis from the surface, volatilization (half-life of 15 to 33 hr), or aerobic biodegradation. Its Koc (soil absorption coefficient) of 19 to 106 suggests MIBK is highly mobile. It is not expected to bioaccumulate in aquatic organisms or absorb to sediments.

**Ecotoxicity Values:** *Angelaius phoeniceus* (Redwinged blackbird) LD<sub>50</sub>, oral, 100 mg/kg; *Carassius auratus* (goldfish) LC<sub>50</sub>, 460 mg/L/24 hr.

**Disposal:** MIBK is a good candidate for fluidized bed incineration at 450 to 890 °C. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**EPA Designations** Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U161

Listed as a CERCLA Hazardous Substance\* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [\* per RCRA, Sec. 3001]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

**Section 8. Special Protection Data**

**Goggles:** Wear protective eyeglasses or splash-proof chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH/MSHA-approved respirator. For < 500 ppm, use any chemical cartridge respirator with an organic vapor cartridge. For < 1000 ppm, use any powered air-purifying respirator with an organic vapor cartridge. For < 3000 ppm, use any supplied air respirator with a full facepiece operated in pressure-demand or positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact. Polyvinyl alcohol with a breakthrough time of > 1 hr is recommended as material for PPG. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.<sup>(103)</sup> **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Thoroughly decontaminate personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

**Section 9. Special Precautions and Comments**

**Storage Requirements:** Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles (Sec. 5). Outside or detached storage is preferred. If this is not feasible, store inside in a standard flammable liquids storage cabinet/room. Storage tanks in the open should be contained to prevent spread of accidentally escaping liquid, and a ramped sill installed at doorways of store-rooms to retain liquid. Install Class 1, Group D electrical equipment. To prevent static sparks, electrically ground and bond all equipment used in MIBK manufacture, use, storage, transfer, and shipping.

**Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

**Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on the CNS, eyes, skin, and respiratory system.

**Transportation Data** (49 CFR 172.102)

IMO Shipping Name: Methyl isobutyl ketone

IMO Hazard Class: 3.2

ID No.: UN1245

IMO Label: Flammable Liquid

IMDG Packaging Group: II

**MSDS Collection References:** 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 148, 153, 159, 162, 163, 164, 167, 168, 171

**Prepared by:** M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CHH; **Medical Review:** AC Darlington, MPH, MD

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SECTION 1. MATERIAL IDENTIFICATION			20		
<b>MATERIAL NAME:</b> TOLUENE  <b>OTHER DESIGNATIONS:</b> Methyl Benzene, Methyl Benzol, Phenylmethane, Toluol, C <sub>7</sub> H <sub>8</sub> , CAS #0108-88-3  <b>MANUFACTURER/SUPPLIER:</b> Available from many suppliers, including: Allied Corp., PO Box 2064R, Morristown, NJ 07960; Telephone: (201) 455-4400 Ashland Chemical Co., Industrial Chemicals & Solvents Div., PO Box 2219, Columbus, OH; Telephone: (614) 889-3844		<b>HMIS</b> H: 2 F: 3 R: 0 PPE* *See sect. 8			
<b>SECTION 2. INGREDIENTS AND HAZARDS</b>			<b>HAZARD DATA</b>		
Toluene   * Current (1985-86) ACGIH TLV. The OSHA PEL is 200 ppm with an acceptable ceiling concentration of 300 ppm and an acceptable maximum peak of 500 ppm/10 minutes. ** Skin designation indicates that toluene can be absorbed through intact skin and contribute to overall exposure. *** Affects the mind.	ca 100	8-hr TLV: 100 ppm, or 375 mg/m <sup>3</sup> * (Skin)**  Man, Inhalation, TClO: 100 ppm: Psychotropic***  Rat, Oral, LD <sub>50</sub> : 5000 mg/kg Rat, Inhalation, LCLo: 4000 ppm/4 hrs. Rabbit, Skin, LD <sub>50</sub> : 14 gm/kg  Human, Eye: 300 ppm			
<b>SECTION 3. PHYSICAL DATA</b>					
Boiling Point ... 231°F (111°C) Vapor Pressure @ 20°C, mm Hg ... 22 Water Solubility @ 20°C, wt. % ... 0.05 Vapor Density (Air = 1) ... 3.14		Evaporation Rate (BuAc = 1) ... 2.24 Specific Gravity (H <sub>2</sub> O = 1) ... 0.866 Melting Point ... -139°F (-95°C) Percent Volatile by Volume ... ca 100 Molecular Weight ... 92.15			
Appearance and odor: Clear, colorless liquid with a characteristic aromatic odor. The odor is detectable to most individuals in the range of 10 to 15 ppm. Because olfactory fatigue occurs rapidly upon exposure to toluene, odor is not a good warning property.					
<b>SECTION 4. FIRE AND EXPLOSION DATA</b>				<b>LOWER</b>	<b>UPPER</b>
Flash Point and Method 40°F (4°C) CC	Autoignition Temp. 896°F (480°C)	Flammability Limits In Air % by Volume		1.27	7.1
<b>EXTINGUISHING MEDIA:</b> Carbon dioxide, dry chemical, alcohol foam. Do not use a solid stream of water because the stream will scatter and spread the fire. Use water spray to cool tanks/containers that are exposed to fire and to disperse vapors. <b>UNUSUAL FIRE/EXPLOSION HAZARDS:</b> This OSHA class IB flammable liquid is a dangerous fire hazard. It is a moderate fire hazard when exposed to oxidizers, heat, sparks, or open flame. Vapors are heavier than air and may travel a considerable distance to an ignition source and flash back. <b>SPECIAL FIRE-FIGHTING PROCEDURES:</b> Fire fighters should wear self-contained breathing apparatus with full facepiece operated in a positive-pressure mode when fighting fires involving toluene.					
<b>SECTION 5. REACTIVITY DATA</b>					
<b>CHEMICAL INCOMPATIBILITIES:</b> Toluene is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. This material is incompatible with strong oxidizing agents, dinitrogen tetroxide, silver perchlorate, tetranitromethane, and uranium hexafluoride. Contact with these materials may cause fire or explosion. Nitric acid and toluene, especially in the presence of sulfuric acid, will produce nitrated compounds that are dangerously explosive.					
<b>CONDITIONS TO AVOID:</b> Avoid exposure to sparks, open flame, hot surfaces, and all sources of heat and ignition. Toluene will attack some forms of plastics, rubber, and coatings. Thermal decomposition or burning produces carbon dioxide and/or carbon monoxide.					

**SECTION 6. HEALTH HAZARD INFORMATION TLV**

Toluene is not considered a carcinogen by the NTP, IARC, or OSHA. **SUMMARY OF RISKS:** Vapors of toluene may cause irritation of the eyes, nose, upper respiratory tract, and skin. Exposure to 200 ppm for 8 hours causes mild fatigue, weakness, confusion, lacrimation (tearing) and paresthesia (a sensation of prickling, tingling, or creeping on the skin that has no objective cause). Exposure to higher concentrations may cause headache, nausea, dizziness, dilated pupils, and euphoria, and, in severe cases, may cause unconsciousness and death. The liquid is irritating to the eyes and skin. Contact with the eyes may cause transient corneal damage, conjunctival irritation, and burns if not promptly removed. Repeated and/or prolonged contact with the skin may cause drying and cracking. It may be absorbed through the skin in toxic amounts. Ingestion causes irritation of the gastrointestinal tract and may cause effects resembling those from inhalation of the vapor. Chronic overexposure to toluene may cause reversible kidney and liver injury. **FIRST AID: EYE CONTACT:** Immediately flush eyes, including under eyelids, with running water for at least 15 minutes. Get medical attention if irritation persists. \* **SKIN CONTACT:** Immediately flush skin (for at least 15 minutes) while removing contaminated shoes and clothing. Wash exposed area with soap and water. Get medical attention if irritation persists or if a large area has been exposed. \* **INHALATION:** Remove victim to fresh air. Restore and/or support breathing as required. Keep victim warm and quiet. Get medical help. \* **INGESTION:** Give victim 1 to 2 glasses of water or milk. Contact a poison control center. Do not induce vomiting unless directed to do so. Transport victim to a medical facility. Never give anything by mouth to a person who is unconscious or convulsing. \* **GET MEDICAL ASSISTANCE =** In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

**SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES**

**SPILL/LEAK:** Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Limit access to spill area to necessary personnel only. Remove leaking containers to safe place if feasible. Cleanup personnel need protection against contact with liquid and inhalation of vapor (see sect. 8). **WASTE DISPOSAL:** Absorb small spills with paper towel or vermiculite. Contain large spills and collect if feasible, or absorb with vermiculite or sand. Place waste solvent or absorbent into closed containers for disposal using nonsparking tools. Liquid can be flushed with water to an open holding area for handling. Do not flush to sewer, watershed, or waterway. **COMMENTS:** Place in suitable container for disposal by a licensed contractor or burn in an approved incinerator. Consider reclaiming by distillation. Contaminated absorbent can be buried in a sanitary landfill. Follow all Federal, state, and local regulations. TLm 96: 100-10 ppm. Toluene is designated as a hazardous waste by the EPA. The EPA (RCRA) HW No. is U220 (40 CFR 261). The reportable quantity (RQ) is 1000 lbs/454 kg (40 CFR 117).

**SECTION 8. SPECIAL PROTECTION INFORMATION**

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute) and be designed to capture heavy vapor. For emergency or nonroutine exposures where the TLV may be exceeded, use an organic chemical cartridge respirator if concentration is less than 200 ppm and an approved canister gas mask or self-contained breathing apparatus with full facepiece if concentration is greater than 200 ppm. Safety glasses or splash goggles should be worn in all work areas. Neoprene gloves, apron, face shield, boots, and other appropriate protective clothing and equipment should be available and worn as necessary to prevent skin and eye contact. Remove contaminated clothing immediately and do not wear it until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

**SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS**

**STORAGE/SEGREGATION:** Store in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, or open flame. Storage areas must meet OSHA requirements for class IB flammable liquids. Use metal safety cans for handling small amounts. Protect containers from physical damage. Use only with adequate ventilation. Avoid contact with eyes, skin, or clothing. Do not inhale or ingest. Use caution when handling this compound because it can be absorbed through intact skin in toxic amounts. **SPECIAL HANDLING/STORAGE:** Ground and bond metal containers and equipment to prevent static sparks when making transfers. Do not smoke in use or storage areas. Use nonsparking tools. **ENGINEERING CONTROLS:** Preplacement and periodic medical exams emphasizing the liver, kidneys, nervous system, lungs, heart, and blood should be provided. Workers exposed to concentrations greater than the action level (50 ppm) should be examined at least once a year. Use of alcohol can aggravate the toxic effects of toluene.

**COMMENTS:** Emptied containers contain product residues. Handle accordingly!  
Toluene is designated as a hazardous substance by the EPA (40 CFR 116). DOT Classification: Flammable liquid. UN1294.  
Data Source(s) Code: 1-9, 12, 16, 20, 21, 24, 26, 34, 81, 82. CR

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Approvals	<i>J. P. DeCenzo</i>
Indust. Hygiene/Safety	<i>JFW</i>
Medical Review	<i>[Signature]</i>

# Material Safety Data Sheet

From Genium's Reference Collection  
 Genium Publishing Corporation  
 1145 Catalyn Street  
 Schenectady, NY 12303-1836 USA  
 (518) 377-8855



No. 318

XYLENE (Mixed Isomers)  
 (Revision D)  
 Issued: November 1980  
 Revised: August 1988

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## SECTION 1. MATERIAL IDENTIFICATION

**Material Name:** XYLENE (Mixed Isomers)

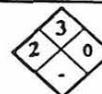
**Description (Origin/Uses):** Used as a raw material for the production of benzoic acid, phthalic anhydride, isophthalic and terephthalic acids and their dimethyl esters in the manufacture of polyester fibers; in sterilizing catgut; with Canadian balsam as oil-immersion in microscopy; and as a cleaning agent in microscopic techniques.

**Other Designations:** Dimethylbenzene; Xylol; C<sub>8</sub>H<sub>10</sub>; CAS No. 1330-20-7

**Manufacturer:** Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek*

**Buyers' Guide** (Genium ref. 73) for a list of suppliers.

**Comments:** Although there are three different isomers of xylene (*ortho*, *meta*, and *para*), the health and physical hazards of all three isomers are very similar. This MSDS is written for a xylene mixture of all three isomers, which is usually commercial xylene.



NFPA

HMIS

H	2	R	1
F	3	I	3
R	0	S	2
PPG*		K	3

\*See sect. 8

## SECTION 2. INGREDIENTS AND HAZARDS

Xylene (Mixed Isomers), CAS No. 1330-20-7\*

\*o-Xylene, CAS No. 0095-47-6

m-Xylene, CAS No. 0108-38-3

p-Xylene, CAS No. 0106-42-3

\*\*Check with your supplier to determine if there are additions, contaminants, or impurities (such as benzene) that are present in reportable quantities per 29 CFR 1910.

\*\*\*Immediately dangerous to life and health.

\*\*\*\* See NIOSH, *RTECS* (No. ZE2100000), for additional data with references to reproductive, irritative, and mutagenic effects.

%

## EXPOSURE LIMITS

IDLH\*\*\* Level: 1000 ppm

OSHA PEL

8-Hr TWA: 100 ppm, 435 mg/m<sup>3</sup>

ACGIH TLVs, 1987-88

TLV-TWA: 100 ppm, 435 mg/m<sup>3</sup>

TLV-STEL: 150 ppm, 655 mg/m<sup>3</sup>

Toxicity Data\*\*\*\*

Human, Inhalation, TC<sub>01</sub>: 200 ppm

Man, Inhalation, LC<sub>50</sub>: 10000 ppm/6 Hrs

Rat, Oral, LD<sub>50</sub>: 4300 mg/kg

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 275°F to 293°F (135°C to 145°C)\*

**Melting Point:** -13°F (-25°C)

**Evaporation Rate:** 0.6 Relative to BuAc = 1

**Specific Gravity** (H<sub>2</sub>O = 1): 0.86

**Water Solubility (%)**: Insoluble

**Molecular Weight:** 106 Grams/Mole

**% Volatile by Volume:** Ca 100

**Vapor Pressure:** 7 to 9 Torrs at 68°F (20°C)

**Vapor Density** (Air = 1): 3.7

**Appearance and Odor:** A clear liquid; aromatic hydrocarbon odor.

\*Materials with wider and narrower boiling ranges are commercially available.

## SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
81°F to 90°F (27°C to 32°C)	867°F (464°C)	% by Volume	1%	7%

**Extinguishing Media:** Use foam, dry chemical, or carbon dioxide. Use water sprays to reduce the rate of burning and to cool containers.

**Unusual Fire or Explosion Hazards:** Xylene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

**Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

Xylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

**Chemical Incompatibilities:** This material may react dangerously with strong oxidizers.

**Conditions to Avoid:** Avoid any exposure to sources of ignition and to strong oxidizers.

**Hazardous Products of Decomposition:** Carbon monoxide (CO) may be evolved during xylene fires.

**SECTION 6. HEALTH HAZARD INFORMATION**

Xylene is not listed as a carcinogen by the IARC, NTP, or OSHA.

**Summary of Risks:** Liquid xylene is a skin irritant and causes erythema, dryness, and defatting; prolonged contact may cause blistering. Inhaling xylene can depress the central nervous system (CNS), and ingesting it can result in gastrointestinal disturbance; and possibly hematemesis (vomiting blood). Effects on the eyes, kidneys, liver, lungs, and the CNS are also reported. **Medical Conditions Aggravated by Long-Term Exposure:** Problems with eyes, skin, central nervous system, kidneys, and liver may be worsened by exposure to xylene. **Target Organs:** CNS, eyes, gastrointestinal tract, blood, liver, kidneys, skin. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Dizziness; excitement; drowsiness; incoordination; staggering gait; irritation of eyes, nose, and throat; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; and dermatitis. **Chronic Effects:** Reversible eye damage, headache, loss of appetite, nervousness, pale skin, and skin rash.

**FIRST AID:** **Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have a trained person administer oxygen. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Vomiting may occur spontaneously, but do not induce it. If vomiting should occur, keep exposed person's head below his or her hips to prevent aspiration (breathing the liquid xylene into the lungs). Severe hemorrhagic pneumonitis with grave, possibly fatal, pulmonary injury can occur from aspirating very small quantities of xylene.

**GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES.** Seek prompt medical assistance for further treatment, observation, and support after first aid. If exposure is severe, hospitalization for at least 72 hours with careful monitoring for delayed onset of pulmonary edema is recommended.

**SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES**

**Spill/Leak:** Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of xylene vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.

**Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

**OSHA Designations**

Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U239

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), section 311 (b) (9)

**SECTION 8. SPECIAL PROTECTION INFORMATION**

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specifics of the work operation to prevent prolonged or repeated skin contact with xylene. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of xylene below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of xylene into general work areas by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make eyewash stations, safety/quick-drench showers, and washing facilities available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean xylene from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale xylene vapor.

**SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS**

**Storage/Segregation:** Store xylene in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage.

**Special Handling/Storage:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations.

**Transportation Data (49 CFR 172.101-2)**

DOT Shipping Name: Xylene

DOT ID No. UN1307

DOT Label: Flammable Liquid

DOT Hazard Class: Flammable Liquid

IMO Label: Flammable Liquid

IMO Class: 3.2 or 3.3

References: 1, 2, 12, 73, 84-94, 100, 103.

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Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

**ATTACHMENT 5-C**  
**EMERGENCY PROCEDURES FOR EXPOSURE**  
**TO HAZARDOUS MATERIALS/WASTE**

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## ATTACHMENT C

### EMERGENCY PROCEDURES FOR EXPOSURE TO HAZARDOUS MATERIALS/WASTE

1. Call ambulance or transport individual to hospital/clinic immediately. Don't forget to take the HASP with you; it contains information on the contaminants expected to be found on the site and will assist the physician in his/her assessment of the exposure.
2. Complete the Potential Exposure Report, answering each of the questions to the best of your ability.
3. Contact our physician(s) at EMR as soon as possible. The procedure is as follows:
  - a. Call EMR at 1-800-229-3674!
  - b. Ask to speak with:  
  
Dr. David L. Barnes; or  
Dr. Elaine Theriault; or  
Ms. T.J. Wolff, R.N.

Note: During nonbusiness hours (after 6pm) call 1-800-229-3674 and follow directions for paging the aforementioned individual(s).

4. Once in contact with any of these individuals, explain what has happened (they will review the information on the form with you and may ask you to fax the form to them, if possible), and allow either of them to speak with the attending physician.
5. When asked about payment (and they will ask), inform the Hospital/Clinic/Physician that this is a "work related injury" and have them contact the Benefits Coordinator at (412) 269-2744. Have invoices sent to:  
  
Michael Baker Jr. Inc.  
Attn: Benefits Coordinator  
Airport Office Park, Bldg. 3  
Coraopolis, PA 15108
6. Contact the Project Manager and the Project Health and Safety Officer as soon as it is feasible, but wait no longer than 24 hours.



POTENTIAL EXPOSURE REPORT

Name: \_\_\_\_\_ Date of Exposure: \_\_\_\_\_

Social Security No.: \_\_\_\_\_ Age: \_\_\_\_\_ Sex: \_\_\_\_\_

I. Exposing Agent

Name of Product or Chemicals (if known) \_\_\_\_\_

Characteristics (if the name is not known)

Solid      Liquid      Gas      Fume      Mist      Vapor

II. Dose Determinants

What was the individual doing? \_\_\_\_\_

How long did the individual work in the area before signs/symptoms developed?

Was protective gear being used? If yes, what was the PPE?

Was there skin contact? \_\_\_\_\_

Was the exposing agent inhaled? \_\_\_\_\_

Were other persons exposed? If yes, did they experience symptoms?

III. Signs and Symptoms (check off appropriate symptoms)

Immediately with Exposure:

- \_\_\_\_\_ Burning of eyes, nose, or throat      \_\_\_\_\_ Chest tightness/pressure
\_\_\_\_\_ Tearing      \_\_\_\_\_ Nausea/vomiting
\_\_\_\_\_ Headache      \_\_\_\_\_ Dizziness
\_\_\_\_\_ Cough      \_\_\_\_\_ Weakness
\_\_\_\_\_ Shortness of breath      \_\_\_\_\_ Heat flashes
\_\_\_\_\_ Delirium      \_\_\_\_\_ Other \_\_\_\_\_

Delayed Symptoms:

- \_\_\_\_\_ Weakness      \_\_\_\_\_ Loss of appetite
\_\_\_\_\_ Nausea/vomiting      \_\_\_\_\_ Abdominal pain
\_\_\_\_\_ Shortness of breath      \_\_\_\_\_ Headache
\_\_\_\_\_ Cough      \_\_\_\_\_ Numbness/tingling
\_\_\_\_\_ Other \_\_\_\_\_

POTENTIAL EXPOSURE REPORT

IV. Present Status of Symptoms (check off appropriate symptoms)

- |   |  |
|---|--|
| <input type="checkbox"/> Burning of eyes, nose, or throat | <input type="checkbox"/> Nausea/vomiting   |
| <input type="checkbox"/> Tearing                          | <input type="checkbox"/> Dizziness         |
| <input type="checkbox"/> Headache                         | <input type="checkbox"/> Weakness          |
| <input type="checkbox"/> Cough                            | <input type="checkbox"/> Loss of appetite  |
| <input type="checkbox"/> Shortness of breath              | <input type="checkbox"/> Abdominal pain    |
| <input type="checkbox"/> Chest tightness/pressure         | <input type="checkbox"/> Numbness/tingling |
| <input type="checkbox"/> Cyanosis (bluish skin color)     | <input type="checkbox"/> Other _____       |

Have symptoms (please check off appropriate response and give duration of symptoms):

Improved \_\_\_\_\_ Worsened \_\_\_\_\_ Remain Unchanged \_\_\_\_\_

V. Treatment of Symptoms (check off appropriate response)

None \_\_\_\_\_ Self-medicated \_\_\_\_\_ Physician treated \_\_\_\_\_

VI. Name \_\_\_\_\_  
(Attending physician)

VII. Hospital/Clinic \_\_\_\_\_

**ATTACHMENT 5-D**  
**DECLARATION OF HASP ADDENDUM REVIEW**

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**DECLARATION OF HASP ADDENDUM REVIEW**

All site personnel indicated below have reviewed and are familiar with the Health and Safety Plan Addendum (Revision 1.0). Site personnel were briefed on the contents of this HASP Addendum on \_\_\_\_\_ at \_\_\_\_\_ a.m./p.m.

- |    |              |           |
|----|--------------|-----------|
| 1. | _____        | _____     |
|    | (Name-Print) | (Company) |
|    | _____        | _____     |
|    | (Name-Sign)  | (Date)    |
| 2. | _____        | _____     |
|    | (Name-Print) | (Company) |
|    | _____        | _____     |
|    | (Name-Sign)  | (Date)    |
| 3. | _____        | _____     |
|    | (Name-Print) | (Company) |
|    | _____        | _____     |
|    | (Name-Sign)  | (Date)    |
| 4. | _____        | _____     |
|    | (Name-Print) | (Company) |
|    | _____        | _____     |
|    | (Name-Sign)  | (Date)    |
| 5. | _____        | _____     |
|    | (Name-Print) | (Company) |
|    | _____        | _____     |
|    | (Name-Sign)  | (Date)    |
| 6. | _____        | _____     |
|    | (Name-Print) | (Company) |
|    | _____        | _____     |
|    | (Name-Sign)  | (Date)    |